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A CONCEPT OF THE ULTRAMICROSCOPIC VIRUS DISEASES AND A CLASSIFICATION[1]

By Professor EARL B. McKINLEY

THE GEORGE WASHINGTON UNIVERSITY MEDICAL SCHOOL

WE[2] have recently attempted to define a filterable virus as a particulate agent, probably endowed with life, of a size and carrying an electric charge which permits it to pass through the pores of ordinary filter candles, as a rule ultramicroscopic (though there may be exceptions), related in many instances to the formation of intracellular inclusion bodies (intracytoplasmic, intranuclear or both). Since disease phenomena have focused our attention upon them they appear to be capable of producing in many instances specific pathologic processes in several different forms of life, including man, lower animals, fowls, fishes, insects and plants.

It is exceedingly difficult to formulate a definition for this large group of agents, which we now, perhaps unfortunately, speak of as the filterable viruses. One may appear foolhardy in attempting such a definition until the exact nature of these agents is known. However, certain developments in the fields of pathology and bacteriology make it of paramount importance at the present time that even with our limited knowledge of the nature of viruses, we attempt to define our problems in order that in the future there may be less confusion than exists at the present moment concerning this group of disease-producing agents. For this reason we have attempted a tentative definition of the filterable viruses and will later present a classification which we suggest as a working basis in thinking of this group of agents.

The history of the virus group is well known and needs no repetition here. Suffice it to say that most

[1] Address at the annual meeting of the American Society for Experimental Pathology, Philadelphia, Pennsylvania, on April 28, 1932.

[2] E. B. McKinley, *The Sci. Monthly*, 32: 398, 1931.

of the discovery which has been made with the virus diseases has taken place during the past four decades since the demonstration by Iwanowski[3] forty years ago that the infecting agent of tobacco mosaic is filterable. Since 1892 the list of virus diseases has grown prodigiously and they now constitute one of the most important and complex group of diseases which challenges the ingenuity and imagination of those in the fields of plant, animal and human pathology. Since 1903 no less than fifteen reviews have been published regarding the filterable virus diseases in attempts to define the field and evaluate the progress which has been made. In recent books by Rivers[4] and his colleagues and our own,[5] published in 1929, the subject has been treated exhaustively, though not conclusively, upon the basis of existing knowledge. In spite of these attempts to keep the virus field defined there has developed a greater confusion and one sees evidence of this not only in the Sunday supplements of the lay press, but also in the minds of some of our colleagues in the biological sciences. It is time therefore that we endeavor to define what we should all have in mind when we think of a filterable or ultramicroscopic virus. Let us therefore consider what is now known concerning the nature of these agents.

There has been a vast amount of discussion regarding the nature of the filterable viruses. While it is true that we know considerable regarding the properties of some of the viruses, such as approximate size, resistance of these agents to physical and chemical agents, cells attacked by them, etc., it is also true that we do not know just what a filterable virus really is. One of the most frequent discussions centers around the question of the living nature of viruses. Are viruses animate or inanimate? Are they minute organisms related to bacteria? Are they a separate species in themselves? Or do they represent inanimate chemical principles or enzymes, etc.? None of these questions have been answered with certainty. Boycott[6] states that he believes that this question of "live or dead" is a stupid one because such a question does not exhaust the possibilities. He would infer that there are varying degrees of "deadness" or "aliveness" and degrees of transition between the two. He would place the filterable viruses in this intermediate group. Be that as it may, there are certain attributes which we associate, in the light of our knowledge and experience, with living things and with dead things. Philosophers have for ages attempted to explain life and death and to determine where one leaves off and the other begins, but up to the present time no one has been able entirely to dissociate such things as reproduction, assimilation and adaptation from living things or the lack of these attributes from dead things. Our difficulty with the filterable viruses lies in the fact that we can not demonstrate that they may reproduce themselves in the test-tube under artificial conditions as do bacteria. Still, there is ample evidence that they do reproduce themselves *in vivo* and with many of them this can be easily demonstrated by introducing a very minute quantity of virus into a susceptible host and when such a host succumbs to the specific infection the virus may be detected in large quantities in different parts of the host's tissues. Furthermore, with a relatively small number of filterable viruses multiplication can be demonstrated in living tissue culture and even specific pathology, if we regard inclusion bodies as such, may be produced in some cases within the living cells of such culture media. There is also evidence that some viruses may be preserved "alive" for a considerable length of time, though not multiplying, outside the living body. For example, if one passes a strain of vaccine virus through a calf one obtains a large quantity of virus in return for a very small original inoculum. Such a virus may be stored in glycerin at a low temperature for a considerable length of time and is again capable of reproducing itself in the body of a susceptible host. But if we store it long enough the time comes when it will not infect a susceptible host . . . it becomes "inactive" and we are justified in considering it "dead" in so far as our purpose is concerned. Certainly then we have abundant evidence which indicates that viruses are probably living things and there is little to suggest the contrary. If we could provisionally agree upon this concept of the living nature of viruses it would serve as a fundamental upon which to base a further analysis.

The susceptibility of various viruses to such physical agents as chemicals, high temperatures, ultra-violet light; the demonstrable fact, now adequately confirmed, that certain viruses may be propagated in tissue culture medium; the gradual deterioration, or destruction, of viruses stored in glycerol at low temperatures; the invasive properties and indeed special affinities of viruses for certain types of cells, etc. . . . all, in our opinion, suggest the living nature of these agents, and such observations offer no indications that we are dealing with inanimate matter. We would insist then at this point that the filterable viruses are minute particulate agents which are most probably endowed with life. Whether they exist as cells, in forms much smaller than those now visible with our present optical instruments, is yet to be determined, but it is conceivable that these extremely minute bodies may exist as miniature granules endowed with

[3] D. Iwanowski, *Beiheft Bot. Centralblat.*, 3: 266, 1893; *Zeit. Pflanzenkrankheit.*, 13: 1, 1903–04.

[4] T. M. Rivers, "Filterable Viruses." Williams and Wilkins, Baltimore, 1928.

[5] E. B. McKinley, "Filterable Virus and Rickettsia Diseases." Bureau of Science, Manila, 1929.

[6] A. E. Boycott, Smithsonian Report for 1929.

properties which constitute positive living attributes and they may possibly be below the structure level of organized cells which we have always considered the unit basis of living matter in the scheme of living things. It is interesting to speculate on these questions and attempt to visualize these minute agents, but in the final analysis it must be admitted that, at the present time, we do not know the precise nature of the filterable viruses nor do we know in what form they exist in nature.

Much has been written regarding bacterial filters and the mechanical technique and physics of filtration. While research on filtration has brought to light many interesting facts and aided greatly in our study of the viruses it has not contributed a great deal to the actual nature of these agents. As Zinsser has so well stated, filtration is only a relative matter. What is known to-day as a result of studies on cataphoresis to determine electric charge can not be regarded as conclusive for the reason that, up to the present time, no virus has been obtained in a pure state. Even the size of viruses is at present only an approximation. However, the study of filters and filtration from the standpoint of the influence of hydrogen-ion concentration, viscosity, surface tension, size of filter pores, density and character of virus suspensions has been exceedingly worth while and has contributed general knowledge which is certainly helpful. Detailed treatments of this subject have appeared in special articles and in monographs and will not be considered here. Suffice it to say that in most of these studies the basic thought in the background has been one related to the determination of the actual size of the filterable viruses. Unfortunately, even if we knew the actual size of a given virus it would not aid us materially in the solution of the more fundamental problems concerning its nature and mode of action as compared with other better-known agents of disease, such as bacteria, protozoa, etc.

Rivers and others have emphasized the fact that viruses differ markedly in their effects upon tissue cells. Not only in the type of influence, whether stimulating or destructive, but also in the degree of effect they produce. Viruses possess certain tendencies to attack definite cells. The virus may be essentially neurotropic or epitheliotropic. Some are characterized by their stimulating influence on cells, such as in molluscum contagiosum and warts, while others may quickly bring about destructive processes, such as smallpox, herpes zoster and foot-and-mouth disease virus. Cells attacked by certain viruses may increase markedly in size and a certain group of viruses are well known to be associated regularly with the formation of inclusion bodies. Woodruff and Goodpasture[7] have presented evidence in the case of fowl-pox that the inclusion bodies contain the actual virus of the disease. A salient point to be remembered is the marked tendency for viruses to attack tissue cells from within . . . that is, they are *intracellular* parasites or disease-producing agents. They differ decidedly in this respect from most bacteria, the greater part of which attack tissue cells from without and are therefore *intercellular,* although the *Mycobacterium leprae* of leprosy is an outstanding exception to this rule. Recent work on the cultivation of the leprosy bacillus, it being an intracelluar parasite, as are most viruses, has suggested the possibility of cultivating viruses on artificial mediums under the influence of various gaseous tensions of carbon dioxide and oxygen. Work along this line is now in progress and other gases, such as helium and neon, are also being employed in the study of certain viruses as well as certain known anaerobes. A report on this work will be presented later. The actual cultivation of a virus on artificial medium is perhaps the most fundamental problem dealing with this subject.

If we may review at this point let us return for a moment to our definition of a virus in which we state, as a working hypothesis, that a virus is a particulate, animate agent, of a size and presumably carrying an electric charge which permits its passage through ordinary filter candles, that it is as a rule ultramicroscopic and is related in many instances to the formation of intracellular inclusion bodies. Some viruses, to be sure, have as yet not been found associated with intracellular bodies, but the list of inclusions is growing rather than decreasing. If we provisionally accept these general characteristics of viruses as a working hypothesis, then we should ask a question concerning which there is a growing source of confusion in this field of study, *i.e.,* What relation, if any, have the filterable viruses to bacteria and more especially to the reputed "filterable forms" of bacteria?

The existence or non-existence of filterable forms of bacteria we do not care to challenge. We regard this question as distinctly outside the realm of the filterable virus problem. Unfortunately, however, the literature has recently associated the terms "filterable forms of bacteria" and "filterable viruses" in a very loose fashion. In our opinion this has been exceedingly unfortunate, for it lacks discrimination and an appreciation of certain fundamental considerations which are inherent in the virus problem and have nothing whatever, except perhaps the superficial question of filtration, to do with the true filterable viruses. As we have pointed out elsewhere[8] there are several fundamental characteristics which set the filterable

[7] E. C. Woodruff and E. W. Goodpasture, *Am. J. Path.,* 5: 1, 1929.

[8] E. B. McKinley, "The Etiology of Epidemic Encephalitis." In press.

viruses apart from bacterial forms. For example, there is a distinct tendency for virus diseases to produce a lasting immunity to subsequent infections, while this tendency is not so marked in bacterial diseases. Furthermore, artificial immunity can only be produced with living viruses, while killed bacteria commonly induce antibody formation when injected into the animal body. Virus infections, as a rule, attack tissue cells from within, while, in most instances, bacteria attack tissue cells from without. A large number of virus diseases are associated with the formation of intracytoplasmic or intranuclear (or both) inclusion bodies. Bacteria do not produce inclusion bodies in tissue cells. We can omit the difference in size between viruses and bacteria as a relative matter. Bacteria are easily cultivated as a rule on artificial culture medium, while no virus as yet has been cultivated, except in the presence of living cells. In addition there are certain epidemiological features of virus diseases which are distinctly different from most bacterial diseases. These are a few of the most important differences between viruses and bacteria, but sufficient, we believe, to permit the statement that with the filterable virus group we are dealing with something quite distinct from bacteria. This is a point which we should like to emphasize in an attempt to define the virus problem.

It may assist some in further elucidating the virus problem to attempt a classification of the diseases now thought to be associated with the filterable viruses. Here again one treads on difficult and debatable terrain in attempting a classification of over eighty diseases, the virus nature of which surely no group of individuals will entirely agree upon at the present time. A few years ago we attempted a classification of the virus diseases along most general lines based upon host susceptibility. This classification was helpful but, of course, too general in scope. During the past three or four years new information concerning many of the virus diseases has come to hand, and we feel it is possible to attempt a classification based upon finer characteristics. Imperfections will exist in any classification of viruses and only the future will give us an ideal grouping of these very interesting diseases. The following classification is based upon the presence or absence of inclusion bodies, upon transmissibility and upon filtrability of the virus in question. Subheadings dividing the diseases according to host susceptibility are also included.

Classification of Virus Diseases

I. Virus Diseases with Cell Inclusions which are Definitely Proved Transmissible and Filtrability of the Causative Agent is Established

- *A. Diseases of Man:*
  - 1. Smallpox
    - Varioloid
    - Vaccinia
    - Paravaccinia
    - Alastrim
  - 2. Verruca (Common warts)
  - 3. Molluscum contagiosum
  - 4. Rabies
  - 5. Herpes febrillis
  - 6. Papilloma of the larynx
  - 7. Yellow fever
- *B. Diseases of Lower Animals:*
  - 1. Pox diseases
    - Cow pox
    - Sheep pox
  - 2. Virus III infection of rabbits
  - 3. Borna disease
  - 4. Distemper
  - 5. Foot-and-mouth disease
  - 6. Myxomatosis of rabbits
  - 7. Rabies
  - 8. Hog cholera
  - 9. Infectious pustular stomatitis of horses
  - 10. Salivary gland disease of guinea-pigs
  - 11. Rift Valley fever (Enzootic hepatitis)
  - 12. Louping-ill
- *C. Diseases of Fowls:*
  - 1. Fowl pox (Avian diphtheria)
  - 2. Fowl plague
  - 3. Virus disease of parrots and parrakeets
- *D. Diseases of Insects:*
  - 1. Polyhedral diseases
    - Gipsy-moth caterpillar
    - European moth caterpillar
    - Tent caterpillar
    - Jaundice of silkworms
- *E. Diseases of Plants:*
  - 1. Mosaic diseases
    - Common examples
      - Tobacco
      - Tomato
      - Potato

II. Virus Diseases with Cell Inclusions which are Transmissible but Filtrability of the Causative Agent has not been Established

- *A. Diseases of Man:*
  - 1. Varicella
  - 2. Inclusion Blennorrhoea
- *B. Diseases of Lower Animals:*
  - 1. Horse pox
- *C. Diseases of Insects:*
  - 1. Polyhedral disease of the black arches moth caterpillar
- *D. Diseases of Fish:*
  - 1. Lymphocystic disease

III. Virus Diseases with Cell Inclusions which are not Transmissible and Filtrability of the Causative Agent has not been Established

A. Diseases of Man:
1. Herpes zoster

B. Diseases of Fish:
1. Carp pox
2. Epithelioma of Barbus

IV. VIRUS DISEASES WITH NO CELL INCLUSIONS WHICH ARE TRANSMISSIBLE AND THE CAUSATIVE AGENT HAS BEEN DEFINITELY ESTABLISHED

A. Diseases of Man:
1. Epidemic parotitis
2. Foot-and-mouth disease
3. Pappataci fever
4. Poliomyelitis
5. Dengue fever
6. Psittacosis
7. Common colds

B. Diseases of Lower Animals:
1. Nairobi disease of sheep
2. Catarrhal fever of sheep
3. Equine influenza
4. Vesicular stomatitis in horses
5. Rinderpest (Cattle plague)
6. Ephemeral fever in horses and cattle
7. Epizootic in guinea-pigs
8. Guinea-pig paralysis
9. Novy's rat disease
10. Cattle warts
11. Fox encephalitis
12. Noguchi's (*Dermacentor andersoni*) virus infection in guinea-pigs and monkeys
13. Infectious bulbar paralysis
14. Pleuropneumonia in cattle
15. Agalactia of sheep
16. Anemia of rats
17. Equine infectious anemia
18. African horse sickness
19. Mad itch

C. Diseases of Fowls:
1. Rous' chicken sarcomata
2. Philippine fowl disease (Newcastle or Ranikhet disease)
3. Leukemia of chickens

D. Diseases of Insects:
1. Sacbrood disease of bees

V. A GROUP OF DISEASES IN SOME CASES FOR WHICH CLAIMS HAVE BEEN MADE FOR SPECIFIC (BACTERIAL, PROTOZOAL, RICKETTSIAL, ETC.) ETIOLOGICAL AGENTS; IN MANY OF WHICH THE FILTRABLE NATURE OF THE CAUSATIVE AGENT REMAINS QUESTIONABLE BUT SUGGESTIVE; AND IN OTHERS INCLUSION BODIES HAVE BEEN REPORTED AND THEIR IDENTIFICATION IS EITHER ESTABLISHED OR REMAINS DOUBTFUL

A. Diseases of Man:
1. Scarlet fever
2. Trachoma
3. Encephalitis
   Epidemic encephalitis
   Vaccinial encephalitis
   Australian X disease
   Encephalitis following measles
   Encephalitis following mumps
   Encephalitis following varicella
4. Epidemic influenza
5. Measles
6. German measles
7. Multiple sclerosis
8. Tsutsugamushi disease
9. Psoriasis
10. Condyloma acuminatum
11. Visceral disease

B. Diseases of Lower Animals:
1. Puppy disease
2. Swine pox
3. Goat pox
4. Kurloff bodies in guinea-pigs
5. Swine influenza (Hog flu)

C. Diseases of Fowls:
1. Fowl paralysis (Neurolymphomatosus)
2. Macfie's disease of fowls
3. Fowl laryngotracheitis

D. Diseases of Insects:
1. Grasserie of the caterpillar of the large white cabbage butterfly
2. Nuclear disease of the caterpillar of the large white cabbage butterfly

E. Diseases of Amphibia:
1. Todd bodies

In offering this classification we are well aware of the difficulties involved. We expect and invite constructive criticism. Objection will come no doubt that certain diseases, such, for example, as scarlet fever, should have no place whatever in the consideration of this field, and yet some investigators insist that it is not fully established that a virus may not be associated with the *Streptococcus scarlatinae* in this infection. Others will question the basis or selection of experimental work upon which a place in the classification is given to a specific virus, but this, again, is a matter of opinion. The classification is not conclusive. It is based upon the literature in the light of our evaluation and interpretation of it. We would expect in such a field of study as the virus field to find disagreement, but on the whole we feel that this grouping, in the form presented, represents a measure of progress in an attempt to bring about some order out of chaos and to assist in a statement of the virus problem which sorely needs definition at this time.

SUMMARY

To summarize, we have attempted a tentative definition of a filterable virus and have reviewed briefly some of the known facts concerning the nature of these agents. Fundamental differences between the true filterable viruses and bacteria, either filterable or non-filterable, have been discussed in an effort to

define the virus problem in contradistinction to the latter. The point of view that a true virus represents a distinct type of disease-producing agent has been presented and emphasized. To further assist in defining the virus field a classification of virus diseases based upon the presence or absence of inclusion bodies, transmissibility of the virus and filtrability of the infecting agent is presented for consideration.

THE ESTABLISHMENT OF PRIORITY IN SCIENTIFIC DISCOVERIES

By Dr. C. A. BROWNE

U. S. DEPARTMENT OF AGRICULTURE

A STUDY of the individual claims for precedence in making discoveries constitutes an interesting chapter in the history of science. The history of the discovery of oxygen and of other chemical elements is filled with controversial claims of this character and the opinions of the critics, who have weighed the evidence in these and other similar cases, have unfortunately been often influenced by feelings of national bias.

An interesting case of recent significance relates to the discovery of the missing element, Number 61, which was named Illinium by Harris and Hopkins in 1926, and Florentium by Rolla and Fernandes, who claim priority for the discovery upon the fact that they deposited a sealed note relating to their work with the Royal National Academy of the Lincei of Florence in 1924. The method of assuring priority by the deposition of sealed notes has been practiced for many years in various European countries. The *Chemiker-Zeitung* in Germany, for example, has conducted a bureau for this purpose since 1895, which gives their subscribers the right to deposit in its keeping sealed communications regarding work which is not yet ripe for publication. The date of the receipt of the deposition is registered and at any time upon request of the sender the sealed envelope may be opened and the dated communication published. The editorial office of the *Chemiker-Zeitung* is careful to inform its clientele, however, that, while the deposition of a sealed note may establish the intellectual ownership of a discovery (das geistige Eigentumsrecht), it does *not* provide for the vindication of patent claims.

Notwithstanding certain conveniences of the sealed deposition procedure, this method of establishing priority has been very generally and correctly frowned upon in English-speaking countries. If an individual, A, for example, deposits such a note, it simply indicates that at the time of the deposition A was not perfectly sure in his own mind of the validity of his discovery. If further work on A's part contradicts the statement in the sealed note, he orders it to be destroyed and is thus saved from the embarrassment of a refutation. It should be remarked, however, that if a rival investigator, B, makes a published announcement of the same discovery before A has completed the confirmation of his work, then B is entitled to the credit, as he anticipated A *in having confidence in the validity of his work.*

The official date of the publication of an article does not usually determine the time when a discovery was made. Months may elapse between the time when an article is received in an editorial office and the official date of publication. On the other hand, cases are known with journals, that were behind with their monthly issues, when the official date of publication of an issue preceded by many months the actual time when a discovery reported therein was made.

The date of receipt, which is usually attached to an article, is now usually accepted as the decisive index of priority. Yet cases are known where authors have inserted later discoveries in the proof sheets of an article that was previously submitted. In all such cases there should be a footnote regarding the date of such insertions. Charges of unfair preference in permitting the dating back of articles for the purpose of securing priority for favored contributions have been made against certain journals, but such unethical procedures, so far as the writer is aware, have never been confirmed.

Authors who are working in closely competitive fields are often anxious to indicate that their findings antedate the appearance of articles by rival investigators—a trait of human nature which Emerson once referred to as a "habit of saliency"—and hence we note the occasional attachment to articles of footnotes regarding the time of making a discovery, the date of a verbal statement or other matters irrelevant to the main subject of the paper. Personal remarks of this character can, of course, have no weight in the establishment of priority.

Some investigators are exceedingly cautious about drawing conclusions from their work, even when these conclusions may seem to be almost self-evident. Cases are known where a clever interpreter, after reviewing the publications of an over-cautious investigator, has foreseen the probable final outcome of an incompleted

research and rushed into print with an anticipatory article in the hope of reaping credit for something upon which he has expended but very little personal effort. The establishment of the premises, upon which the final conclusion is based, is, however, the question of most importance and the investigator who was the first to establish these premises by laborious research is entitled to the rewards of priority, although his caution always to verify the steps of his argument by every possible check may have caused him to delay the announcement of the almost obvious conclusion of his work.

An interesting example of the coincidence of published announcements of the same discovery is the recent publication of the constitutional formula of rotenone within the brief space of a few weeks by four wholly independent workers in America, Germany, England and Japan. The history of the investigation of this substance, which is finding increased use as an insecticide, discloses a number of interesting problems of priority.

In 1895, Geoffroy in France obtained from the stems of *Robinia* (now *Lonchocarpus*) *nicou*, a plant growing in South America, a crystalline substance which he called "nicouline" and which agreed in melting point and other properties with the substance afterwards called rotenone. Geoffroy should, therefore, probably be given the credit of having first isolated this compound in a state of purity.

In 1902, Nagai in Japan obtained from *Derris chinensis* a white crystalline compound melting at 163°, which he named "rotenone" because it was found to be a ketone and was derived from a plant called "*rohten*" in the Japanese language.

In 1911, Lenz in Germany isolated from *Derris elliptica* a crystalline substance which he named "derrin," and in 1916 Ishikawa in Japan isolated from the same plant a similar compound which he called "tubatoxin." These chemists were apparently ignorant of earlier investigations and therefore did not know that their crystalline materials were identical with the rotenone of Nagai or the nicouline of Geoffroy.

In 1923, Takei in Japan began a vigorous investigation of the chemical constitution of rotenone and in 1928 proposed for this substance the empirical formula $C_{23}H_{22}O_6$. In 1926, Butenandt in Germany entered the field and in his inaugural dissertation (Göttingen) of May 4, 1927, announced the formula $C_{23}H_{22}O_6$ that was later published by Takei.

In 1929, LaForge, Smith, Haller and Clark, of the Bureau of Chemistry and Soils, in their investigation of new insecticidal substances, took up the study of the active constituents of *Derris elliptica, Lonchocarpus nicou, Cracca toxicaria, Cracca vogelii* and other plants which had been used as fish-poisons by the natives of Asia, Africa and South America. In 1930, Clark isolated from the roots of *Derris elliptica* the three new compounds "deguelin," $C_{23}H_{22}O_6$, "toxicarol," $C_{23}H_{22}O_7$, and "tephrosin," $C_{23}H_{22}O_7$. Clark also found deguelin (an isomer of rotenone) and toxicarol to occur in the roots of *Cracca toxicaria*, and rotenone, deguelin and tephrosin to occur in the roots of *Lonchocarpus nicou*. He showed one half of the molecules of deguelin and tephrosin, as is the case with rotenone, to consist of derric acid and discovered the important fact that this portion of the molecule of the three substances yielded 2-hydroxy-4, 5-dimethoxy benzoic acid, thus establishing the orientation of the methoxyl groups in these compounds. Clark thus proved for the first time the remarkable similarity in constitution of the active principles of three different plants that were used as fish-poisons by natives in three widely separated sections of the world.

The work upon rotenone, deguelin, tephrosin and toxicarol was actively carried forward at the Bureau of Chemistry and Soils, and in the early part of November, 1931, the structural formula of rotenone was first definitely established by LaForge and Haller, their article upon the subject (No. XIX, in the Rotenone series) being received by the *Journal* of the American Chemical Society upon November 20, 1931, and published in this journal on February 5, 1932. Immediately following this work of LaForge and Haller upon rotenone was the provisional establishment by Clark of the structural formulas of the closely related substances, deguelin and tephrosin; the submission of his papers upon these compounds was postponed, however, for the completion of confirmatory analyses.

Meanwhile Butenandt, in Germany, was actively engaged in the continuance of the work upon rotenone, which he had begun in 1926. In an article submitted to Liebig's Annalen on February 10, 1932, and published on March 4, 1932, he submitted a structural formula for rotenone which is identical with that previously announced by LaForge and Haller. The *Journal* of the American Chemical Society of February 5, containing the article by LaForge and Haller, reached Butenandt while he was correcting the proof of his own paper. This coincidence, remarkable as it is, is paralleled, however, by an equally striking occurrence, which was the submission of an article by Robertson to the *Journal* of the Chemical Society of London on February 27, 1932, (only 17 days later than the submission of the article by Butenandt to the Annalen) upon the "Constitution of Rotenone, Deguelin and Tephrosin," in which the structural formula of rotenone, proposed by LaForge and Haller,

was also independently confirmed. Robertson adds in a footnote that his views were communicated privately to Professor R. Robinson, of Oxford, on January 20, 1932, before he had seen the publication by LaForge and Haller. Robertson's article (No. 2 of his series) was published in the *Journal* of the London Chemical Society for May, 1932.

Closely following the publication of Robertson's article was the appearance in the *Berichte* of the German Chemical Society for June 8, 1932, of a paper by Takei, Miyajima and Ono (submitted on May 21, 1932), who withdrew the structural formula of rotenone which they had previously proposed and submitted a new formula which was identical with the one first proposed by LaForge and Haller.

This announcement of the same discovery by four groups of chemists, working wholly independently of one another in four different countries, within so brief a space of time is probably without a parallel in the whole history of chemistry.[1]

With the establishment of the formula of rotenone, the structures of the closely related substances, deguelin and tephrosin, were deducible from the published articles of Clark, who, except for a few late experiments by Butenandt, has been the only chemist to conduct laboratory investigations upon these two derivatives, and was the first to point out the close structural relationships between rotenone, deguelin, tephrosin and toxicarol. Such deductions were in fact made by Clark, as previously stated, at the time of completion of the article upon rotenone by LaForge and Haller in November, 1931, but he deferred publication of the structures of deguelin and tephrosin until the completion of other confirmatory laboratory investigations. Clark's article upon the structure of deguelin and tephrosin was received by the *Journal* of the American Chemical Society on May 3, 1932, and published on July 6, 1932. His final laboratory investigations confirmed the formulas which he had previously assigned to deguelin and tephrosin in November, 1931, and which had been correctly deduced from his work by Butenandt in his article published in the *Annalen* on May 20, 1932, and by Robertson in his article in the *Journal* of the London Chemical Society for May, 1932. Inasmuch as everything that has been published concerning the constitution of deguelin and tephrosin is based upon the experimental work of Clark, the credit for having established the structure of these compounds belongs in greatest measure to him.

Provisional formulas for the structure of toxicarol have been proposed by both Butenandt and Clark. The suggested formulas however, are somewhat different and the final determination of its structure must await further research.

It is very apparent that the means for prompt publication are better organized in certain foreign countries than in the United States. Butenandt's paper, for example, upon the constitution of rotenone was submitted upon February 10, and published on March 4, 1932, whereas the paper of LaForge and Haller, submitted on November 20, 1931, was not published until February 5, 1932. Special consideration was probably given for the immediate publication of Butenandt's paper, as the average interval between the dates of submission and publication in the *Annalen* is greater than in this particular instance. It should also be noted that German chemists are favored by a greater number of journals in which publication can be secured.

As a means for shortening the delay between the submission and publication of a discovery, the writer would suggest the following procedure: When a piece of scientific work is completed the essential facts of the discovery are to be reported as soon as possible with the deposition of a copy of the paper, before the most convenient scientific society (academy, lyceum, local chemical society, etc.), the date of presentation to serve as the official date of announcement. Simultaneously, a brief abstract of the communication is to be submitted to the most available scientific journal (such as SCIENCE, one of the publications of the American Chemical Society, etc.) for prompt publication in a special section of "Comptes Rendus," or "Official Reports," which also shall give the date of the presentation before the local scientific society. These official abstracts must necessarily be of the briefest possible character and give only the essential part of the discovery. The date of announcement having been fixed, the publication of the complete paper can then await the usual course of events, without the necessity of giving impatient investigators the benefit of special consideration. In case there are no local societies available for the preliminary announcement, the prepared abstract can be sent directly to the desired scientific journal, but in this case the date of the receipt of the communication by the journal can be the only determining factor in the establishment of priority. It is believed that this plan, or some modification of the same, will help to solve some of the problems in connection with the establishment of priority in closely contested fields, of which the case of rotenone is only one example.

[1] I. Houben, of the Chem. Lab. der Biolog. Reichs-Anstalt, Berlin-Dahlem, in his recent article "Ueber insektentötende Pflanzenstoffe (Anzeiger für Schädlingskunde, V. 8 (1932) No. 7, pp. 83–88), gives a complete review and bibliography of the researches upon rotenone, deguelin, tephrosin and toxicarol. He also claims independent discovery of the constitutional formula of rotenone.

OBITUARY

FRANK PELL UNDERHILL

(1877–1932)

IN the death of Dr. Frank Pell Underhill medical science has lost an active and enthusiastic worker in the fields of physiology and pharmacology, whose accomplishments brought credit alike to him and to the university with which he was connected.

Endowed with high ideals of true scholarship, Dr. Underhill's experimental work always bore the marks of painstaking accuracy with a just appreciation of the value of truth, with the result that his conclusions were universally recognized as based upon trustworthy evidence. In the classroom and in the laboratory he strove diligently to inculcate in his students the same regard for truth, the same spirit of research that animated him, the many joint papers coming from the laboratory testifying to the value of his influence in the training of younger investigators in his chosen field of work. To such men as Underhill the scientific world owes much, for upon their labors the present-day advances in science are largely dependent. Men like Underhill give impulse and stimulus to men of lesser intellectual advancement and thereby help to raise the level of scientific accomplishments.

Dr. Underhill graduated from the Sheffield Scientific School in 1900 with his interest in physiological chemistry well developed, and after three years of graduate study he received the degree of doctor of philosophy. From 1903 to 1907 he served as instructor and from 1907 to 1918 as assistant professor of physiological chemistry in the Sheffield Scientific School, but from 1912 to the college year 1918–1919 he occupied also the position of professor of pathological chemistry in the Yale Medical School. For the following three years the title of his chair was changed to that of experimental medicine. On the reorganization of the university in 1921 he was appointed professor of pharmacology and toxicology in the school of medicine, which position he occupied up to the time of his decease. Thus, for nearly thirty years Underhill, through his ability as a teacher and his activities in research, was a potent factor in the development of physiological activities at Yale University.

During the years 1907–1918 five volumes of "Studies in Physiological Chemistry" came from the Sheffield Laboratory, of which Underhill was one of the editors and where a large number of his researches appeared. Among his earlier contributions reference may be made to his studies of carbohydrate metabolism, such as "The Mechanism of Phlorhizin Diabetes"; "The Rôle of Calcium in the Regulation of Blood Sugar Content"; "The Relation of the Acid-Base Equilibrium of the Body to Carbohydrate Metabolism and its Application in Human Diabetes." Equally worthy of note are his studies of "The Physiological Action of Tartrates"; "Tartrate Nephritis"; "The Physiological Action of Some Protein Derivatives"; "The Metabolism of Ammonium Salts"; "Creative Metabolism." In 1915 he published his book on "The Physiology of the Amino Acids," which gives a good résumé of knowledge of these important components up to that date.

During the world war Underhill was in charge of an investigation by the section on intermediary metabolism of the Medical Division of the Chemical Warfare Service, with the rank of lieutenant-colonel, and in 1920 there appeared the book "Lethal War Gases, Physiology and Experimental Treatment." In 1921 he published a "Manual of Selected Biochemical Methods," as applied to urine, blood and gastric analysis, and in 1924 there appeared a volume entitled "Toxicology, or the Effects of Poisons." During the later years of his life he was much occupied with a study of the pathological chemistry of burns, with many suggestions as to treatment.

Such briefly is a partial outline of the scientific activities of this man whose life was devoted to the experimental study of physiological problems of great importance. What he accomplished will stand throughout the years as a striking memorial of his great industry, of his skill in arriving at definite results and of his judgment in drawing correct conclusions from his experimental work. He was typical of the best to be found among the scientific workers of his generation.

RUSSELL H. CHITTENDEN

YALE UNIVERSITY

RECENT DEATHS

DR. ADAM CAPEN GILL, emeritus professor of mineralogy and petrography at Cornell University, died on November 8, at the age of sixty-nine years.

DR. SIDNEY POWERS, consulting geologist of the Amerada Petroleum Corporation, died on November 6, at the age of forty-two years.

A CORRESPONDENT writes: Wilhelm N. Suksdorf, who for years was the outstanding field botanist of the Pacific Northwest, was struck by a train and killed near his home at Bingen, Washington, on October 3. As a result of financial aid toward his field work and taxonomic studies given by the State College of Washington through a number of years, sometime before his death Mr. Suksdorf executed a will by the terms of which his very considerable private herbarium and

his botanical library are to be turned over to the college.

DR. HELEN UPDEGRAFF (Mrs. Arthur F. Cary), physiological chemist in the chemical laboratory of the Massachusetts Eye and Ear Infirmary, died on October 25. She was a daughter of Dr. Milton Updegraff, professor of mathematics, U. S. Navy, retired.

ALFRED BOSTOCK HILL, emeritus professor of hygiene and public health at Birmingham University, died on November 6. He was seventy-eight years old.

SCIENTIFIC EVENTS

INDUSTRIAL RESEARCH IN GREAT BRITAIN

THE report of the Committee on New Industrial Development set up by the British Economic Advisory Council in March, 1931, under the chairmanship of Mr. J. H. Thomas, has been issued. The conclusions are summarized as follows:

Having examined the various arguments which have been put forward in support of the proposed establishment of a new national research organization as outlined in our terms of reference, we consider that such an organization would cut right across the existing organization of the Department of Scientific and Industrial Research, and would be likely in practice, by the confusion of purpose and distraction of effort it would cause, to injure rather than to forward the cause of scientific research in British industry.

Moreover, we are satisfied that the existing government organization for the promotion of industrial research is efficient, and is sufficiently flexible to enable it to develop along such lines as may be desirable to meet the changing needs of industry.

We are, therefore, unable to recommend the establishment of a new national organization along the lines suggested.

It is highly desirable that there should be at the disposal of government a small fund capable of being readily used for research developments, such as that which is at present at the disposal of the Advisory Council for Scientific and Industrial Research. We consider, therefore, that when the balance of this fund is surrendered to the Exchequer at the end of the current year a sum of money should continue to be available for expenditure on research developments or unforeseen requirements by suitable provision in the department's annual estimate.

The evidence which we have received shows clearly how valuable are the services rendered to industry by the research associations established by particular industries, and we trust that it will be possible for his Majesty's Government to continue to provide financial assistance to these bodies on a scale sufficient to enable them to function effectively until such time as industry is in a position to bear the whole of their cost.

Dealing in the report with the suggestion that there is a gap in our research arrangements, the committee says that it doubts whether greater progress would be secured by attempting to work on more centralized lines, inasmuch as the value of research depends on a readiness to apply its results. Moreover, the Department of Scientific and Industrial Research is always willing to create organizations of its own in important industrial fields where it recognizes that a need for research exists. The committee holds, also, that there appears to be little danger in practice that discoveries arising in one part of the industrial field, as the by-product of research there carried on, will be wasted through lack of knowledge of them in the industries to which they are chiefly of interest.

The committee considers that the question of the extent to which facilities should be provided for large-scale tests, or for what is sometimes called "development research," is not one that can be settled in general terms, and that so far as organization is concerned, the requirements of development research seem to be adequately provided for by the machinery of the Department of Scientific and Industrial Research and provide no useful scope for the creation of a new organization.

SCIENTIFIC WORK IN CHINA

THREE years ago there was organized in the Little Gorges, near Chungking of Szechuan province, an Academy of Science of Western China. This institute is supported primarily by private contributions. It has now an annual budget of $40,000 Mex. for research and survey work in geology and biology. With the help of Dr. H. H. Hu, director of Fan Memorial Institute of Biology at Peiping, a herbarium and a botanical garden has been established by the academy, with a view to exploring all parts of the province and eastern Tibet and to collecting seeds, cuttings, bulbs, etc., for planting in the botanical garden. It is planned to establish in the garden a nursery where seeds and bulbs will be provided for sale or exchange. For instance, the collector was instructed to collect seeds of Rehderodendron, a new genus of three species of ornamental trees of Styracaceae, recently described by Dr. Hu. Seeds of other interesting and ornamental plants will be assiduously collected. The Arnold Arboretum of Harvard University will be the first in the United States to share a part of this collection. This year two parties have been sent out by the arboretum to collect herbarium specimens and seeds, one to eastern, another to southwestern, Szechuan.

The latter is exploring the bordering district along the Szechuan-Yunnan-Tibet borderland. In the winter the collector will bring herbarium specimens and seeds to the Fan Institute for study and identification, as that institute has a large herbarium and a large botanical library, and furthermore a unique collection of photographs of the type-specimens of Chinese and other Asiatic countries taken in various European herbaria, amounting to the large number of 17,000.

In the spring of 1932 a joint botanical and zoological expedition was sent to eastern Yunnan by the Fan Memorial Institute of Biology, Peiping, starting from western Szechuan and exploring the bordering regions of Szechuan, Kweichow and Yunnan. The party expects to be wintered in Yunnanfu. The botanical staff will endeavor to explore regions not yet thoroughly worked over and will collect specimens in the type-localities. Besides collecting flowering plants, special attention will be paid to mosses, liverworts, ferns and other cryptogams. The zoological staff will collect birds, fishes, other lower vertebrates and land shells. News has been received that the party succeeded in penetrating the forbidden territories of Ta-Liang-Shan lololands, where probably no white man has ever entered. The lolos are very warlike tribes, who frequently kidnap Chinese and make them slaves. The present powerful chieftainess is the sister of the present military governor of Yunnan, and has enlightened views as to the purpose of scientific expeditions. Members of the party were welcomed as her guests. Oxen and pigs were slaughtered in their honor, and an elderman of the tribe was handed over to the district magistrate as the pledge of their safety. As two years ago the lamentable death of the eminent young Chinese paleontologist, Ya-Tseng Chao, at the hands of bandits had cost the district magistrate of Chao Tung Hsien a permanent dismissal from office, this precaution is carefully taken by his successor. The party plans to explore the southeastern part of Yunnan next year.

A. B. D. FORTWYN,
Secretary of the Peking Society of Natural History.

THE MORRIS ARBORETUM AND THE UNIVERSITY OF PENNSYLVANIA

WITH the establishment of the Morris Arboretum as a part of the University of Pennsylvania the university is now looking forward to a time when it will become an important center for botanical study and research.

The arboretum, which was bequeathed to the university by the late Miss Lydia Thompson Morris, of Philadelphia, who also established the Morris Foundation with a liberal endowment for the support of the arboretum and for the support, in part, of the work in botany at Pennsylvania, covers 170 acres and is one of the outstanding arboretums of the country.

It is situated in Chestnut Hill in the heart of one of the most picturesque sections in the Philadelphia suburban area and is within easy access of the University campus in West Philadelphia. Included in the arboretum are two estates, "Compton," which was the home of Miss Morris, and "Bloomfield," an adjoining estate.

The Morris Arboretum had its beginning during the life-time of John T. Morris, brother of Miss Morris, who began to assemble a collection of trees and shrubs at "Compton" and who, through cooperation with Dr. C. S. Sargent and the Arnold Arboretum, of Boston, in the expeditions of E. H. Wilson into the Orient, obtained many treasures from eastern Asia.

The collection of coniferous evergreens is an exceptionally fine feature of "Compton" and includes not only Asian, African, Australian and European species, but some of the rare kinds from western North America. Young specimens of the Sequoia gigantea, of California, are among the later plantings, and the one-leafed pine, *Pinus monophylla,* from the arid southwest, is of much interest to the scientific student of trees.

To the critical botanist the collection of thorn-apples, Crataegus, also is of particular interest, the great variety and richness of this collection giving evidence of the close relation between "Compton" and Dr. Sargent. The Albizzia, or jujube tree, near its northern limit at "Compton," Sargent's oak and many other specimen trees claim attention.

The university has not yet formulated its entire program for the utilization of the Morris Arboretum, but an indication of the extent and variety of the activities which will center around the arboretum is provided through the will of Miss Morris in which she expressed eight specific desires relative to the administration of "Compton" and "Bloomfield." These are:

That "Compton" and "Bloomfield" be maintained as an arboretum, and that use of income for this purpose be not subordinated to any other purpose.

That a laboratory for botanical research and dissemination of knowledge be maintained, although not necessarily on the estate.

That research be conducted in this country and abroad.

That scholarships to send boys and girls to school and college to study horticulture and kindred subjects be established.

That a post-graduate course be maintained at "Compton" and "Bloomfield."

That books and pamphlets, free or at cost, be published on the research work or kindred subjects.

That eminent scientific lecturers be employed.

That plants be distributed to the public.

H. L. H.

THE AWARD OF THE PERKIN MEDAL

GEORGE OENSLAGER, chemist at the B. F. Goodrich Company Laboratories at Akron, Ohio, has been awarded the Perkin Medal for 1933. It is given annually for the most valuable work in applied chemistry and regarded as one of the highest honors which can be conferred upon an American chemist.

Mr. Oenslager's selection is based on the pioneering work he has accomplished for the rubber industry on organic accelerators, besides other chemical research. In 1906 he started work to find a means by which the cheaper wild rubbers could be made to vulcanize as rapidly as those of high grade and also to result in as good or better finished product. It was his untiring effort on that problem that resulted in the use of organic compositions as accelerators of vulcanization. Their use permitted rubber to be vulcanized in only a fraction of the time formerly required and brought about greater life to tires and all other rubber products. It is estimated that chemical research work on organic accelerators alone has brought a saving to motorists of at least $50,000,000 a year.

The Perkin Medal is awarded by the American section of the Society of Chemical Industry and is made to any chemist in the United States for work done at any time during his career. A committee representing the American section of the Society of Chemical Industry, the American Chemical Society, the Electrochemical Society, the American Institute of Chemical Engineers and the Société de Chimie industrielle of France makes the award. The medal will be presented at a joint meeting of these societies in New York City on January 6.

Established in 1906 by Sir William H. Perkin, the first medal was awarded to Sir William for his pioneer work in the synthetic dye industry. The complete list of recipients of the medal follows:

J. B. F. Herreshoff, improvement in chamber process for sulfuric acid; Arno Behr, work in corn products; E. G. Acheson, development of carborundum; Charles M. Hall, development of process for manufacture of aluminum; Herman Frasch, contribution to refining of Canadian and Ohio petroleums.

James Gayley, invention of dry air blast for manufacture of iron; John W. Hyatt, discovery of celluloid and development of its manufacture; Edward Weston, achievements in electrodeposition of metals; Leo H. Baekeland, discoverer of Velox paper, Bakelite and other synthetic resins; Ernst Twitchell, work with organic sulfo acids; Auguste J. Rossi, achievements in field of titanium steel and other titanium alloys; F. G. Cottrell, recovery of helium from natural gas wells.

Charles F. Chandler, work as educator and expert in field of industrial chemistry; Willis R. Whitney, achievements as research director of General Electric Conpany; William M. Burton, for high temperature process of cracking petroleum under pressure.

Milton C. Whitaker, achievements in manufacture of alcohol, ethyl acetate, acetone and other solvents; Frederick M. Becket, process of extraction of rare metals from ores; Hugh K. Moore, development of electrolytic processes for chlorine and caustic soda; R. B. Moore, achievements in the field of helium and radioactive elements.

John E. Teeple, achievements in manufacture of acids; Irving Langmuir, accomplishments in field of low pressures, conduction and radiation of heat; E. C. Sullivan, development of special glasses for heat resistance; Herbert H. Dow, developments in production of chlorine and alkali; Arthur D. Little, work as a pioneer in application of research to industry and development of processes; Charles F. Burgess, development of the dry cell.

SCIENTIFIC NOTES AND NEWS

DR. IRVING LANGMUIR, assistant director of the Research Laboratory of the General Electric Company at Schenectady, New York, has been awarded the Nobel Prize in chemistry.

THE honorary degree of doctor of medicine was conferred by the University of Upsala on Sir Charles Sherrington, Waynflete professor of physiology at the University of Oxford, in connection with the Gustavus Adolphus celebrations on November 4.

THE triennial award of the De Morgan Medal of the Mathematical Society, London, has been made to Bertrand Russell in recognition of his mathematical work. The medal was presented at the annual general meeting of the society on November 10.

THE Max Planck Medal has been awarded to Dr Max von Laue, professor of theoretical physics at the University of Berlin.

AT the annual dinner of the Royal Society of Medicine, London, on November 17, Sir Thomas Barlow was presented with the gold medal of the society.

THE chemists whose names are given below have been nominated for 1933 for the office of president-elect of the American Chemical Society: Dr. Edward Bartow, professor and head of the department of chemistry and chemical engineering at the State University of Iowa; Dr. C. A. Browne, chief of chemical and technological research of the Bureau of Chemistry and Soils, U. S. Department of Agriculture; Dr. William Lloyd Evans, professor of chemistry and chairman of the department at the Ohio State Uni-

versity; A. C. Fieldner, chief engineer of the Experiment Stations Division, U. S. Bureau of Mines; Oliver Kamm, scientific director of the Research Laboratories of Parke, Davis and Company; Dr. S. C. Lind, director, School of Chemistry of the University of Minnesota; Thomas Midgley, Jr., consultant, General Motors Corporation, executive of the Ethyl Gasoline Corporation; Dr. Charles L. Reese, retired in 1931 as chemical director of the E. I. du Pont de Nemours and Company; C. M. A. Stine, vice-president, director and member of the executive committee of the E. I. du Pont de Nemours and Company; J. W. Watson, professor and head of the department of chemistry and chemical engineering, Virginia Polytechnic Institute.

ROBERT E. DOHERTY, professor of electrical engineering in Yale University, has been appointed dean of the School of Engineering. Professor Doherty, who had been associated with the General Electric Company since 1909, joined the faculty of Yale University a year ago.

N. F. MOTT, fellow of Caius College, Cambridge, and university lecturer in mathematics, has been appointed to the Melville Wills chair of theoretical physics in the Wills Physical Laboratory at the University of Bristol in succession to Professor Lennard-Jones, the appointment to be effective in August, 1933. Dr. C. M. Yonge, of the Marine Biological Laboratory, Plymouth, has been appointed to the chair of zoology.

THE title of emeritus professor of mathematics in the University of London was conferred on Professor S. A. F. White on his retirement from the chair of mathematics at King's College, London.

IN the issue of SCIENCE for October 28, a reference was inadvertently made to the "recent retirement" of Arthur Keith from the U. S. Geological Survey. Mr. Keith is geologist of the survey, as he has been since 1894.

PROFESSOR MARSTON T. BOGERT, of Columbia University, has been appointed by the U. S. Department of Agriculture a permanent collaborator in the Bureau of Chemistry and Soils. On nomination by the American Chemical Society he has been appointed its representative on the Division of Chemistry and Chemical Technology of the National Research Council.

WARD SHEPARD, forest economist, has received an award from the Oberländer Trust of the Carl Schurz Memorial Foundation, Philadelphia, which will enable him to make a study of German forestry, particularly from the economic standpoint, giving special attention to the relationship of forests to the industrial and social welfare of communities.

SIR GEORGE SEATON BUCHANAN, senior medical officer of the Ministry of Health and delegate for the United Kingdom, has been appointed president of the Permanent Committee of the Office international d'Hygiène publique, in succession to the late M. Otto Velghe, secretary-general of the Ministère de l'Intérieur et de l'Hygiène at Brussels, who had held that office continuously from 1919 until his death at Geneva, which occurred suddenly while he was attending the session of the Health Committee of the League of Nations on October 11.

EDWARD W. ALLEN, of Seattle, Washington, has been appointed to succeed Miller Freeman as one of the two American members of the International Fisheries Commission.

PROFESSOR ALBERT EINSTEIN will sail for the United States on December 10, traveling to California by way of the Panama Canal. Next winter he will take up his work at the Institute for Advanced Study at Princeton, New Jersey.

DR. E. WALDSCHMIDT-LEITZ, of the Institut für Biochemie, Technische Hochschule, Prague, together with three of his assistants, Drs. Purr, Koehler and Weil, will work on the relation of enzymes to cancer research in the laboratories of the Graduate School of Medicine at the University of Pennsylvania.

THE Committee on Scientific Research of the American Medical Association has recently made a grant to Dr. Willard O. Thompson, of the Rush Medical College, Chicago, in order that Joseph M. Alper, of the Harvard Medical School, Boston, may continue work with him on the relation between thyroxine and the glutathione oxidation system.

THE Council of the Institution of Civil Engineers has awarded the Indian Premium for the session 1931–32 to Sir Bernard D'O. Darley (Bahawalpur, Punjab), and the Webb Prize for the session to Mr. B. G. White (London) for papers read and discussed at ordinary meetings of the institution. The following awards for the session have been made for "Selected Engineering Papers," published without discussion: A Telford Gold Medal to Dr. J. F. Baker, Abbots Langley; Telford Premiums to Mr. William Muirhead, London; Mr. E. B. Cocks, London; Dr. James Orr, Glasgow; Dr. W. J. Walker, Johannesburg, and Mr. W. C. Ash, Vizagapatam, India, and a Crampton Prize to Mr. L. St. C. Rundlett, Rangoon, Burma.

Nature reports that at the annual meeting of the Royal Society of Edinburgh, held on October 24, the following officers were elected: *President,* Sir E. A. Sharpey-Schafer; *Vice-presidents,* Professor J. H. Ashworth; Dr. A. Logan Turner; Dr. J. B. Clark; Professor James Ritchie; Sir Thomas Holland; The Honorable Lord Sands; *General Secretary,* Professor

R. A. Sampson; *Secretaries to Ordinary Meetings,* Professor C. G. Darwin and Professor F. A. E. Crew; *Treasurer,* Dr. James Watt; *Curator of Library and Museum,* Professor D'Arcy W. Thompson; *Councilors,* Dr. Murray Macgregor; Dr. A. Crichton Mitchell; Professor P. T. Herring; Professor James P. Kendall; Professor T. M. MacRobert; Professor Godfrey H. Thomson; Dr. Malcolm Wilson; Professor E. B. Bailey; Professor J. C. Brash; Professor A. J. Clark; Professor A. G. Ogilvie, and Professor E. M. Wedderburn.

DR. C. MACFIE CAMPBELL, professor of psychiatry at the Harvard Medical School, will give, at a date to be announced, six evening Lowell Lectures on "Human Personality and the Environment."

DR. ERNEST SACHS, professor of clinical neurological surgery in the Washington University School of Medicine, will give a two-weeks course of lectures before the Honolulu Medical Society.

DR. EDWARD C. SCHNEIDER, professor of biology at Wesleyan University, spoke on November 1 before the students and faculty of the University of Colorado School of Medicine and Hospitals in Denver, on "Physiological Reactions of Man to High Altitudes and Low Oxygen."

SIR JAMES JEANS will deliver the Henry Sidgwick Memorial Lecture on November 26 at Newnham College, Cambridge. The subject of the lecture will be "The Farthest Depths of Space."

THE Cyrus Fogg Brackett Lectures at Princeton University School of Engineering for 1932–1933 are as follows: October 11, James A. Farrell, formerly president of the United States Steel Corporation, "The Engineer in Foreign Trade"; December 13, B. E. Hutchinson, vice-president and treasurer, Chrysler Corporation, Detroit, "The Automobile Industry"; January 10, 1933, George B. Cortelyou, president, Consolidated Gas Company of New York, "The Gas Industry"; February 14, Charles Donnelly, president, Northern Pacific Railway Company, St. Paul, "The Pacific Northwest"; March 14, George E. Vincent, formerly president of the Rockefeller Foundation, "A Scientific Adventure"; April 11, Jonathan Jones, chief engineer, McClintic-Marshall Corporation, Bethlehem, Pennsylvania, "Modern Trends in the Construction of Steel Bridges."

THE forty-fifth annual meeting of the Geological Society of America will be held on Wednesday, Thursday and Friday, December 28–30, at Cambridge, Massachusetts, under the auspices of the Boston Geological Society, Harvard University and the Massachusetts Institute of Technology. Headquarters will be at the Harvard Union, where the scientific sessions will be held. The address of the retiring president, Dr. Reginald A. Daly, will be delivered at the Walker Memorial Hall at the Massachusetts Institute of Technology on December 28, at 8 o'clock P. M. His subject will be "The Depths of the Earth." The regular dinner of the society will be held on Thursday evening, December 29, at 7 o'clock, in the Harvard Union. The Paleontological Society and the Mineralogical Society will hold their annual meetings in conjunction with the Geological Society.

THE Society of American Bacteriologists will hold its annual meeting in Ann Arbor, Michigan, from December 28 to 30, inclusive, under the presidency of Professor Edwin B. Fred, of the University of Wisconsin. This meeting is dedicated to Anton van Leeuwenhoek, the tercentenary of whose birth will be commemorated. A historical exhibit of Leeuwenhoekiana will be shown. The scientific program will emphasize the physical and chemical aspects of bacteriology and immunology. Round-table discussions will be held on (1) Bacterial filtrability, dissociation and life cycles, (2) Microbiology of frozen foods and (3) Taxonomy.

THE nineteenth annual meeting of the Wilson Ornithological Club will be held in Columbus on November 25, 26 and 27. The meetings will be held in the auditorium of the Ohio State Museum on the campus of the Ohio State University.

THE second annual meeting of the Inter-Society Color Council will open at Columbia University College of Pharmacy on December 28.

THE regular three-year session of the International Union of Forest Experiment Stations was held this year at the Forest School, Nancy, France. Professor Guinier, head of the Forest School at Nancy, was the president, and the staff of the Forest School and the Experiment Station conducted the excursions. The trip before the congress, which was intended to give a bird's-eye picture of the forest types of France, was under the leadership of Messrs. Roudin and Schaeffer. Starting at Rouen it went south to the Pyrenees, then east to the Rhone and north to the foothills of the Alps, reaching Nancy after two weeks of railroad travel and automobiling. The principal topics at the congress were the methods to be used in measuring sample plots and describing them, and the measures desirable to take to prevent destructive erosion, especially in Alpine regions. After the congress there was a special excursion of a week, which was intended to show the work which the French Forest Service has done in the Mediterranean region. In spite of the depression the attendance was fairly good. About fifty representatives of some thirty countries attended the

sessions so that the proceedings were truly international in character. The United States was represented by C. F. Korstian, B. Moore and K. W. Woodward. Professor G. Roth, of Hungary, is the president for the next congress, which will meet at Hungary in 1936. E. N. Munns, of the U. S. Forest Service, is the vice-president.

AN American standard value to be used by industry in converting inches to millimeters was recommended by a general conference held recently under the auspices of the American Standards Association, following a request of the Ford Motor Company. The conference was presided over by Dr. P. G. Agnew, secretary of the association. Representatives of 18 industrial groups having an interest in precise measurements and methods of limit gaging were present. The conference unanimously recommended the conversion factor of one inch equals 25.4 millimeters to become the American standard value for industrial use, replacing for this purpose both the official ratio 25.40005 and the rounded value 25.4001 given in certain handbooks and tables. The official British ratio is 25.399978, and the last precise experimentally determined value 25.399956. Thus the British official value is about one part in a million below, and the American official value about two parts in a million above 25.4. British industry, through the British Standards Institution, adopted the value 25.4 for industrial use in 1930. This simple ratio has been advocated by Continental European countries. The adoption of the conversion ratio 25.4 by American industry will secure world-wide uniformity in conversion practice. For example, an American automobile manufacturer having plants in both metric and inch countries, desiring to have complete interchangeability of parts regardless of the country in which they are made, can use identical blue-prints in the respective countries on the basis of the uniform conversion ratio 25.4.

Industrial and Engineering Chemistry reports that at the Denver meeting of the American Chemical Society the Division of Chemical Education took the following action regarding the reinstatement of Professor J. N. Swan at the University of Mississippi: "At the Cincinnati meeting of the American Chemical Society in September, 1930, the Division of Chemical Education expressed a vigorous protest against the unjust and summary dismissal from the University of Mississippi of J. N. Swan, then chairman of this division. As an evidence of our confidence in Dr. Swan he was again elected chairman. Ours seems to have been one of the first of many organizations to protest against this and other removals under the régime of Governor Bilbo. In view of the recent reinstatement of Dr. Swan and others we wish to express our commendation and appreciation of the new spirit now evident in Mississippi and to congratulate Governor Connor and others in authority. The vindication and reinstatement of Dr. Swan mean much to him and to us but much more to the State of Mississippi."

Museum News reports that the Brooklyn Institute of Arts and Sciences is to receive nearly all the $1,673,000 estate of the late Victor Wilbour. Mr. Wilbour's sister and brother-in-law, E. H. Blashfield, have renounced their shares in favor of the institute, which will then receive all except $20,000 that goes to the Historical Society of Rhode Island.

DR. WILLIAM L. RICHARDSON, who died on October 20, made a bequest of $100,000 to Harvard University for the endowment of a professorship of obstetrics and another of $40,000 for the establishment of the Jeffrey Richardson Fellowship. His library, with the exception of his medical books, also was left to the university.

FORMAL administration of the Bear River (Utah) Migratory-Bird Refuge by the Bureau of Biological Survey began on October 1, the effective date of the administrative regulations prescribed on September 28 by Acting Secretary Dunlap. An executive proclamation issued on September 26 established boundaries for the refuge, a 64,255-acre marsh area at the mouth of Bear River, considered one of the most important breeding, feeding and concentration areas in the West for ducks, geese and shore birds. About 28,000 acres of the refuge area is flooded and about 40 per cent. of this was designated as public shooting grounds by the acting secretary, under the act of Congress providing for establishment of the refuge. The rest of the area will be administered as an inviolate sanctuary.

THE superintendent of documents, Government Printing Office, Washington, D. C., has for sale a recently issued detailed index to subjects and authors of the publications of the United States Department of Agriculture for the period 1901–1925, inclusive. It covers all the publications of the department for the period given with the exception of the periodicals issued by the bureaus. *The Journal of Agricultural Research* and *The Official Record* of the department are included. As the publication contains an analytical index of the numerous subjects covered by the department's extensive published research for a quarter of a century, it will be of value to those investigators and research institutions that have occasion to refer to the work or results of the department for that period. The index contains 2,689 pages and is bound in one volume in buckram.

DISCUSSION

A PROPOSED COMPENDIUM OF CULTURE METHODS FOR THE LESSER INVERTEBRATE ANIMALS

AT the Syracuse meeting of the Association in June I suggested cooperation among zoologists in the preparation of a compendium of methods of rearing and maintaining cultures of the lesser invertebrate animals. These animals are needed for experimental purposes and for laboratory use. Many such animals have been kept in dwindling cultures for a time, but I fear that very few have been reared successfully through repeated generations. The methods for these few have cost much time and labor and are not very widely known. They are hidden away in scattered papers whose titles usually give no hint of their presence. It seemed to me that future workers would be greatly aided by making the knowledge of successful cultural practices more available.

The idea was favorably discussed in the opening meeting of Section F. I now invite the consideration of the wider circle of zoologists who are readers of SCIENCE. What I have in mind is a compendium of the best knowledge available concerning the collecting, feeding, sheltering, breeding, etc., of the lesser invertebrates: in short, everything that has to do with maintaining cultures of them. Perhaps there is not much known, aside from a few classic forms, such as Drosophila, Daphnia, Paramoecium, etc.; but perhaps there is more known than we suspect (the discussion at the Syracuse meeting would indicate this); and perhaps if what is known were brought together and studied there might appear some general rules of management of great value.

My thought was, and is, that if a small committee of interested zoologists were commissioned by their colleagues to gather and sift such material, and publish it in a book, the job might be done through cooperation without too great expenditure of time. I have thought that such a book would have for me the help that Lee's "Microtomists' Vade Mecum" had when I began to work alone on animal tissues. I have in mind a small book that any one could afford to own, that would avoid on the one hand anecdotes and freak plans, and on the other hand such futilities as mathematics prematurely applied to inadequate data. In these days of emphasis on the use of living animals is not such a book much needed?

If the question that I here raise elicits sufficient response from the zoologists who may chance to read this, I will at the Atlantic City meeting of Section F propose such a committee, together with cooperative arrangements to facilitate its functioning.

JAMES G. NEEDHAM

CORNELL UNIVERSITY

PHYCOMYCETES, ASCOMYCETES AND FUNGI IMPERFECTI IN OKLAHOMA SOIL

ACCORDING to Waksman,[1] work on soil fungi has been done in Europe, Japan, and in the United States in New York, Michigan, New Jersey, Idaho, and other of the northern and eastern states. However, no counts heretofore have been reported from Oklahoma. This study was made by the plating method, and included the fungi in typical Cleveland County, Oklahoma, soils. Only the noteworthy results and explanations follow.

In general, the counts of Phycomycetes, Ascomycetes and *Fungi imperfecti* made in Oklahoma are higher than those made in northern states. The samples were taken at four different depths in the soil: Sample A, 2 cm below the surface; sample B, 8 cm; sample C, 20 cm; sample D, 40 cm. The work extended over a year. The averages were: Sample A, 313,000 per gram of soil; sample B, 423,000; sample C, 134,000; sample D, 195,000. Waksman gives the average numbers of fungi in soils farther north as follows: At a depth of 2 inches, from 30,000 to 120,000; at a depth of 6 inches, from about 15,000 to 90,000; at a depth of 10 inches, 10,000 to 35,000. Averages for only our very loose sandy soils were: Sample A, 537,000; sample B, 1,277,000; sample C, 224,000; sample D, 216,000. The averages for the finest, most closely packed soils were: Sample A, 230,000; sample B, 217,000; sample C, 129,000; sample D, 365,000.

A notable fact was the large percentages of *Aspergillus niger* present. Of the total number of Phycomycetes, Ascomycetes and *Fungi imperfecti* found at the two cm depth, 43.7 per cent. were *Aspergillus niger;* at the eight cm depth, 38.9 per cent.; at the twenty cm depth, 26.6 per cent.; and at the forty cm depth, 25.2 per cent. A factor here may have been that *Aspergillus niger,* like all other members of this genus, is strictly aerobic.[2]

RAMONA L. TODD

UNIVERSITY OF OKLAHOMA

MITOCHONDRIA AS CENTROSOMES

IN the papers presented at the New Orleans meeting of the American Association for the Advancement of science on the alveolar structure of the mitotic spindle and the self-repulsion of chromosomes, I did not include the evidence corroborative of those observations as given by the variant locations of the mitochondria during mitosis. The *Amblystoma punctatum* material with which I have been working

[1] S. A. Waksman, "Principles of Soil Microbiology," 1927.

[2] Charles Thom and Margaret B. Church, "The Aspergilli," p. 49. 1926.

for the last three years is uniformly remarkable for the absence of centrospheres, whether it be in an egg undergoing its first cleavage or through intermediate stages up to a 30 mm embryo. What might be considered to be centrosomes, however, are frequently present, but these have in every case proved to be aggregates of mitochondria located at or near the poles of the spindle, particularly during anaphase. As cell-division by mitosis is so universal, it would seem that these assumed dynamic centers might be in other animals, as in Amblystoma, merely the result of vortical currents causing temporary aggregation of mitochondria. Fixatives containing acid, such as Bouin's or Zenker's fluids, do *not* ordinarily *completely* dissolve mitochondria, so that their use could easily give rise to a "central body" contained in a "centrosphere"; or acid staining or destaining could give the same appearance. The controversy concerning the character of central bodies might well be ended, therefore, if the technique required for mitochondria were employed in the preparation of the material to be observed.

HERBERT G. COAR
DARTMOUTH MEDICAL SCHOOL

FRESH-WATER MEDUSAE

Craspedacusta ryderi Potts appeared in Swissvale, Allegheny County, Pennsylvania, on or near August 8 of this year. They were found living in a reservoir of the Union Switch and Signal Company. The reservoir is fed from the city water supply and is approximately fifteen by twenty-two feet and is fourteen feet deep. The bottom is bare of any growth, but the walls are covered with algae. On October 1 they were still reported present.

The only explanation for the presence of these animals is that the Hydroid form must have been brought in on fish. These were brought from Lake Erie. There is hardly any chance that they arrived through the city water supply due to the heavy chlorine content. From all available literature it seems that this is the fifth record of the occurrence of fresh-water medusae in the United States, and, for that matter, in the western hemisphere.

STANLEY T. BROOKS
CARNEGIE MUSEUM,
PITTSBURGH, PENNSYLVANIA

SPECIAL CORRESPONDENCE

NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL EXCURSION

THE twenty-eighth annual New England Intercollegiate Geological Excursion was held in the vicinity of Providence and Newport, Rhode Island, on October 14 and 15, 1932. The department of geology of Brown University (Charles W. Brown, chairman) had charge of the arrangements.

The group assembled at Faunce Hall, Brown University at noon on Friday. After lunch President Barbour, of the university, spoke a few words of welcome. They then journeyed eastward by automobile to the east bank of the Seekonk River, where varved clays were exposed, overlain by cross-bedded, aeolian sands. Two other glacial localities were later visited in succession along Highway No. 6, an esker situated approximately a mile southeast of the village of Seekonk, and a rock-core exposed by a steam shovel in a gravel pit two miles west of Swansea.

Having crossed the Taunton River, the party journeyed southward from Fall River and stopped first at the water tower, a mile or so from the center of the city. Here is exposed the Fall River granite, probably a much faulted variety of the Dedham granodiorite. Following Route No. 138 they turned aside to an exposure on the bay-shore, one and one half miles southwest of North Tiverton. The Pondville conglomerate was found to have a deceptive contact with the Dedham granodiorite. Elsewhere it is known that a weathered arkose from the granodiorite rests unconformably on the igneous rock, but here the arkose is very slightly developed and the granodiorite might be thought to be intrustive into the Pondville conglomerate.

The next stop was made on the shore of the Sakonnet River, a half mile south of Tiverton. The basal arkose, underlying the Pondville conglomerate, was well exposed and included thin seams of slate. The slaty cleavage, developed at an angle to the true bedding, allowed the structural geologist to detect certain indications of the direction of forces which folded and metamorphosed these rocks. Salt water has corroded the feldspars of the arkose and produced a porous sponge of quartz. A brief visit was made to the Portsmouth "coal" mine, at which place beautiful specimens of graphite were collected.

The party found its way at twilight to the Army and Navy Y. M. C. A., where it made its headquarters for the night. During the evening a business session was held in the assembly hall, after which members of the department of geology at Brown University spoke briefly. Dr. C. C. Branson defended the proposition that the Pondville conglomerate rested unconformably on the Fall River granite, Mr. J. S. Beach discussed the thickness of the Rhode Island Carboniferous series,

and Dr. A. W. Quinn outlined the geology of the vicinity of Newport in anticipation of the morrow's field-trip.

On Saturday morning a study was made first of the relations of the Carboniferous black shales to the Cambrian or Precambrian quartzites and greenstones near "Miramar," the estate of Dr. Alexander Hamilton Rice. The western peninsula of Newport was then visited. On the south shore, west of Viking beach, a series of banded black shales offered a complex study of secondary banding produced by flowage under pressure. Somewhat similar structures were found in a conglomerate composed of granite pebbles with quartzite lenses at the entrance to Fort Adams. The pebbles had been mashed and rolled until the resulting gneiss was hardly recognizable as a conglomerate. At Purgatory, near the public beach east of Newport, an igneous dike has weathered away, leaving a chasm a few feet wide with vertical walls composed of the Dighton conglomerate. Quartzite pebbles in the conglomerate have been elongated by pressure from the east into cigar-shaped forms. Fractures across the pebbles offer an important study in the mechanics of yielding under stress. Some of these Carboniferous pebbles were found to contain Cambrian brachiopods.

After a delightful luncheon at "Miramar," the party crossed by ferry to Jamestown and visited Mackerel Cove at the southern end of the island. Here the basal arkose of the Carboniferous rests on a granite. Two important questions were not answered: (1) Is the granite of the same age as the Sterling in eastern Connecticut or does it correspond to the Dedham granodiorite of southeastern Massachusetts? (2) Does the arkose rest unconformably on the granite or is the contact due to faulting?

Again the automobiles were driven onto a ferry and at Saunderstown the shore road was taken toward Narragansett Pier. Three miles south of the ferry the Kingston Carboniferous series is invaded by many pegmatite dikes. At Boston Neck near Watson Pier the waves have eroded away the less resistant shales and sandstones and the dikes stand out in relief. Some believe these dikes are members of the Sterling granite series and, hence, that the Sterling batholiths are post-Carboniferous in age. Others would assign them to another series and place the Sterling batholiths in a Pre-Carboniferous period. Manifestly, the correct solution of the problems at Mackerel Cove would also help to solve the difficulty here.

Twenty-three automobiles carrying between sixty and seventy students and teachers from nearly every college in New England made an imposing cavalcade. The wonderful weather and the hospitality of our hosts combined with more interesting geologic problems to make the excursion a memorable occasion.

WILBUR G. FOYE,
Secretary

SCIENTIFIC BOOKS

Kosmos. By WILLEM DE SITTER. Pages viii + 138. Harvard University Press, 1932. Price, $1.75.

DR. WILLEM DE SITTER has contributed so much to modern theories of our universe that any book from his pen must command the attention of the scientific world and of the intelligent reader who would keep in touch with the rapid expansion of astronomical concepts. This new volume puts in permanent form the substance of a series of lectures presented at the Lowell Institute in Boston in the autumn of 1931. It is a scholarly treatment of the evolution of ideas regarding the structure of the universe from ancient times to the present day.

After an introduction covering the aims and methods of scientific research and the attainments of astronomy to the day of Copernicus, Dr. de Sitter reviews in rapid succession the contributions of seventeenth century astronomy as exemplified in the labors of Kepler, Galileo and Newton. With the enunciation of the law of gravitation through the mathematical genius of Newton the classical laws of planetary motion became established and the foundation was laid for an analysis of the motions of planets and stars throughout the universe.

In no uncertain praise Dr. de Sitter does credit to the rare gifts of Herschel in envisioning concepts of the whole universe, while at the same time applying himself assiduously to details of observation necessary for the foundation upon which any satisfactory theory of the universe must ultimately rest. The conclusions which Herschel reached were based on assumptions that we now know are not valid. "Nevertheless no single astronomer either before or after him has done so much for the final solution as William Herschel."

High tribute is paid to the pioneer work of Kapteyn, of Groningen, in developing methods of attack on the problem of the distances of the stars through the new science of stellar statistics. The author's elucidation of the details of Kapteyn's method is somewhat technical in places, but even the general reader will be impressed with his painstaking care. In Chapter 5, somewhat more popularly descriptive, Dr. de Sitter reviews the contributions of modern photography and spectroscopy which have made possible the extension

of Kapteyn's method to even greater distances. Here we find a careful résumé of Shapley's analysis of globular clusters which forms the basis of present-day views of the galactic structure. The extraordinary size of our own galactic system, as compared with distant spiral nebulae, is still a matter of great concern in modern astronomy. Sad experience has trained the scientist to be wary of introducing the term "exceptional" in his conceptions of the universe.

The closing chapter of "Kosmos" deals with "Relativity and Modern Theories" and gives an excellent summary of the contributions of Einstein and of the author with regard to the more theoretical aspects of the properties and distribution of matter and space. In conclusion, Dr. de Sitter remarks:

> Our conception of the structure of the universe bears all the marks of a transitory structure. It is not possible to predict how long our present views and interpretations will remain unaltered and how soon they will have to be replaced by perhaps very different ones, based on new observational data and new critical insight in their connection with other data. . . . By the use of mathematics, that most nearly perfect and most immaterial tool of the human mind, we try to transcend as much as possible the limitations imposed by our finiteness and materiality, and to penetrate ever nearer to the understanding of the mysterious unity of the Kosmos.

HARLAN T. STETSON

PERKINS OBSERVATORY,
DELAWARE, OHIO

Electric Clocks. By F. HOPE-JONES. xv + 259 pp.; 127 figs. London: N. A. G. Press, 1931. 12s. 6d.

EVER since the discovery of electromagnetism, nearly one hundred years ago, men have sought to find some way of time measurement. The author in this volume has made an exhaustive study of the evolution and development of devices which have been proposed for the improved measurement of time.

He has grouped his discussion about three heads, namely: (1) Independent self-contained clocks whose motive power is electrical; (2) synchronizing systems in which a signal is transmitted at regular intervals to correct the hands of independent clocks of all kinds; (3) electrical impulse dials, in which a master clock transmits impulses at minute, or half minute intervals, to propel the hands.

His descriptions are generally clear, but suffer in places by being too brief, or otherwise inadequate to convey the idea which he is trying to impart. Many of the figures also are too crude or too carelessly drawn to be readily understood by one who has not seen the mechanism. From a perusal of the work, one idea above all others emerges, namely, the astounding accuracy of the free pendulum and slave clock, to which the author contributed the remontoir, and W. H. Short the impulse mechanism, and the method of synchronizing the slave with the free pendulum. The performance of the Short clock has equalled if not exceeded the accuracy of the transit observations themselves.

It seems as though the author ought to have mentioned the application of the quartz-crystal controlled oscillator to time measurements. At the last reports on the performance of this device, it showed a constancy of one part in ten million over a period of some days.

The author mentions the Telechron system, by which a wheel work is actuated by a synchronous motor, operated on city service A. C. circuits, which are held to a constant frequency, but does not seem to know of the very extensive vogue which the system has attained in the United States. The convenience of obtaining a clock which requires no attention, and is accurate to four or five seconds, by merely plugging in on a house lighting circuit, seems likely to displace all other clocks for civil purposes. This, combined with the frequent distribution of time signals by radio, has changed the attitude of the whole world towards clocks.

F. E. BEACH

YALE UNIVERSITY

An Introduction to the Literature of Vertebrate Zoology. (Based Chiefly on the Titles in the Blacker Library of Zoology, the Emma Shearer Wood Library of Ornithology, the Bibliotheca Osleriana and Other Libraries of McGill University). By CASEY A. WOOD, xix, 643 pages, colored frontispiece. Oxford University Press, 1931. Price, 3 guineas.

IN the preparation of this work, Dr. Wood has rendered an important service to students of vertebrate zoology, who have been greatly in need of a systematic and comprehensive treatment of the literature of their field. An undertaking of this magnitude inevitably presents features for blame as well as for praise. As a bibliography of a large division of the field of zoology, it leaves much to be desired. It suffers from the limitation of having been compiled in the libraries of a single university. The entries vary in completeness from full citations to fragments, such as "Zooiasis. 1834–6? Leipzig." The treatment of periodical literature is extremely inadequate. Pamphlets are in many cases referred to simply as "author's reprints," with no indication of the original place of publication. But on the other hand the work possesses outstanding merits more than sufficient to compensate for its shortcomings Where else can one

discover in a few moments the title of an authoritative work on the birds of British Guiana or the fishes of Zanzibar?

The volume, of quarto size, is divided into three parts. In the first of these, a running commentary of 146 pages on the history of the literature of vertebrate zoology from the time of Aristotle down to the present, the author has achieved the remarkable feat of being so interesting that one may open at any page and find himself immediately engrossed in the text. Dr. Wood has brought to his task a freshness of style and a conciseness of expression which must be the envy of all reviewers, as it is of the present writer. Such subjects are included as early Greek, Roman and Oriental zoologists, medieval writers on zoology, the Renaissance and its effect on zoological writings, the literature of comparative zoology, forerunners, contemporaries and successors of Linnaeus, animal painters and illustrators, zoological gardens and museums, travelogues of explorers, and other topics too numerous to mention. The reader who wishes to orient himself in the general literature of vertebrate zoology will find here a veritable treasure-house of information.

The second portion of the work consists of a classified index to authors of treatises on different groups of vertebrates and different geographical areas, so arranged that one may find in a moment a selected group of references on, say, the fishes of Europe or the mammals of South Africa.

Having located in this way the name of an author of a standard reference on the subject in question, one turns next to the third portion of the volume, which consists of a partially annotated catalogue of the titles on vertebrate zoology in the McGill University Libraries. Here he will find the detailed citation of the work he desires to consult, with, in many cases, a note regarding the nature of the treatise which may indicate its probable usefulness.

While the work is obviously of greater value to persons having access to the libraries of McGill University than to any one else, nevertheless its general utility is so great that no library of zoology can afford to be without it. Although he who consults the volume in quest of the literature dealing with his own particular specialty is likely to be disappointed by the omissions he will discover, on the other hand, any one wishing to become acquainted with the literature of a portion of the vertebrate field with which he is unfamiliar will bless Dr. Wood for the care and labor he has expended in smoothing the way.

ROBERT C. MILLER

UNIVERSITY OF WASHINGTON

SOCIETIES AND MEETINGS

THE INTERNATIONAL CONGRESS OF MATHEMATICIANS, ZURICH, SEPTEMBER 4–12, 1932

IF any evidence were needed of the rapid development of mathematics in the last third of a century it might well be found in a study of the programs of the several sections of this Congress and of the number and nature of the papers read. In the early years of these quadrennial meetings four sections were considered sufficient; at present there are twice as many. At first the countries represented were chiefly European, the number of members from other continents being relatively small; but in this congress between 40 and 50 nations were represented and the attendance approximated 650 men and 200 women. Of the latter, several were on the mathematical staffs of various American colleges, most of the others being associate members incidentally visiting the congress. The United States and Canada were represented by between 65 and 70 mathematicians and about 25 associates, between 20 and 30 reports or papers being listed.

The congress was divided as usual into two kinds of meetings, six forenoons being occupied by general sessions, at which 22 lectures on new phases of advanced mathematics were given, and four afternoons being devoted to section meetings. There were eight of these sections as follows: I. Algebra and the Theory of Numbers; II. Analysis (three subsections); III. Geometry (two subsections); IV. Probability, Statistics, Insurance; V. Astronomy and Technical Mathematics; VI. Mechanics and Mathematical Physics; VII. Philosophy and History; VIII. Education.

The papers listed in the various sections, not all of which were read, numbered 268. Certain minor changes were made in the programs of the various sessions, and the lists given below are based chiefly upon the latest information supplied by the official bureau.

Each paper was written in one of the four international languages recognized by the congress—English, French, German and Italian. In general the contributors from countries speaking other languages (such as Holland, Russia, Greece, Portugal, the Balkan states, Scandinavia and South America) prepared their papers in French or in German. The fact, therefore, that an address was given in French, for example, does not signify that it was of French origin. There is some value, however, in observing the languages in which current mathematical investigations

are made known, and hence the following table has been prepared to show their distribution in the papers of the various sections mentioned above:

Sections	I	II	III	IV	V	VI	VII	VIII	Totals
French	6	44	17	5	3	28	4	5	112
German	13	24	23	8	5	14	6	2	95
English	6	12	7	2	1	3	2	4	37
Italian	1	11	4	2	0	5	1	0	24
	26	91	51	17	9	50	13	11	268

The fact that the congress was held in a trilingual country, although one in which French and German predominate, must be considered in drawing conclusions from this table, as must also other geographical factors.

The interests manifested in the several sections, as shown by the respective number of papers, is more significant. For example, it will be seen that Section II. (analysis, with three subsections) leads with 91 papers; Section III (geometry, with two subsections) and Section VI (mechanics and mathematical physics) come next with 51 and 50 papers respectively, while Section I (algebra and the theory of numbers) follows with 26 papers, and Section IV (probability, statistics, insurance) with 17. The other sections have 13 or less.

Although it is to be expected that the countries adjacent to Switzerland would be more fully represented than those at a greater distance, there is some significance in the geographical distribution of the papers. For this reason a table has been prepared showing the number of authors or co-authors of papers listed under each country represented in the official bulletins. It should be understood, however, that a number of the writers were absent and that some of their papers were not presented. There were also a few slight errors in the official statements owing to the confusion of the names of contributors or of places. Nevertheless, the following table shows approximately the number of writers of papers listed in the several sections as belonging to the various countries represented:

Germany	46	Great Britain	10
France	38	Poland	9
Italy	28	Jugoslavia	6
America*	23	Austria	6
Switzerland	18	Holland	5
Russia	15	Norway	4
Czechoslovakia	11	Sweden	4

All others, 23, ranging from 1 to 3.

* The term "America" includes the United States and Canada.

It will be observed that the four leading countries were Germany (46), France (38), Italy (28) and America (23), but several other items will also attract attention, such as the number of contributors from Russia (15), Czechoslovakia (11), and Poland (9) and the relatively small number from Great Britain and the other states of the British Commonwealth. As to Russia there has been a rather popular feeling in other countries that she is concerned only with the immediate applications of mathematics to the industrial field. It is therefore interesting to observe that most of the papers read by the Russian contributors were in the domain of abstract analysis, eleven being devoted to this subject, two to technical mathematics, four to mechanics and physics, two to geometry, one to probability and statistics, and one to number theory, philosophy, history or teaching. The number of papers is manifestly too small to render possible any definite conclusions as to the range of Russian interest in mathematics, but it is sufficient to show that the subject is not looked upon by the Soviet states as merely utilitarian in the narrow sense.

It is impossible in a report so limited as this to give any satisfactory résumé of nearly 300 lectures or papers, or even to mention more than a few titles. Two lists have therefore been prepared, the first giving the titles of the lectures listed in the general program, and the second the titles of section papers by Americans.

The first of these lists, important as bearing upon the general trend of higher mathematics at the present time, is as follows:

R. FUETER: Idealtheorie und Funktionentheorie.

C. CARATHÉODORY: "Über die analytischen Abbildungen durch Funktionen mehrerer Veränderlicher."

G. JULIA: "Essai sur le Développement de la Théorie des Fonctions De variables complexes."

W. PAULI: "Mathematische Methoden der Quantenmechanik."

N. TSCHEROTARÖW: "Die Aufgaben der modernen Galois'schen Theorie."

T. CARLEMAN: "Sur la Théorie des Équations intégrals linéaires et ses Applications."

E. CARTAN: "Sur les Espaces riemanniens symétriques."

L. BIEBERBACH: "Operationsbereiche von Funktionen."

M. MORSE: "The Calculus of Variations in the Large."

E. NOETHER: "Hyperkomplexe Systeme in ihren Beziehungen zur kommutativen Algebra und zur Zahlentheorie."

H. BOHR: "Fastperiodische Funktionen einer komplexen Veränderlichen."

F. SEVERI: "La Théorie générale des Fonctions analytiques de plusieurs Variables et la Géométrie algébrique."

R. NEVANLINNA: Über die Riemannsche Fläche einer analytischen Funktion."

R. WAVRE: "L'aspect analytique du Problème des Figures planétaires."

J. W. ALEXANDER: "Some Problems in Topology."

F. RIESZ: "Sur l'Existence de la Dérivée des Fonctions d'une Variable réelle et des fonctions d'intervalle."

G. H. HARDY: "Recent Work in Additive Theory of Numbers."

G. VALIRON: "Le Théorème de Borel-Julia dans la Théorie des Fonctions méromorphes."

W. SIERPINSKI: "Sur les Ensembles de Points qu'on sait Définir effectivement."

S. BERNSTEIN: "Sur les Liaisons entre quantités aléatoires."

K. MENGER: "Neuere Methoden und Probleme der Geometrie."

J. STENZEL: "Anschauung und Denken in der klassischen Theorie der griechischen Mathematik."

As to the papers listed in the various sections it will doubtless be of interest to American readers to be informed concerning the nature of those contributed by the United States and Canada. While it is not feasible to give the titles in full, much less to give any summaries of the papers themselves, the general topics as listed (a few of the papers not being read) are as follows:

C. R. ADAMS, Providence: "Definitions of Bounded Variations for Functions of Two Variables."

J. A. CLARKSON, Providence, collaborator in the preceding paper.

ELIZ. B. COWLEY, Pittsburgh; "Vocabularies in Geometry."

LOUISE CUMMINGS, New York: "Comparison of Straight-line Nets."

L. L. DINES, Saskatoon: "On Linear Inequalities."

S. GANDZ, New York: "On Alphabetic Numerals." Read by D. E. Smith.

O. E. GLENN, Lansdowne, "Mechanics of the Stability of a Central Orbit."

E. HILLE, Princeton: Two papers with J. D. TAMARKIN (Providence) on the summation of Fourier series.

T. R. HOLLCROFT, New York: "General Web of Surfaces."

EDW. KASNER, New York: (1) "Conformity in Connection with Functions of Two Variables"; (2) "Curvative Theorems in Dynamics"; (3) "Element Transformations of Space for which Normal Congruences of Curves are Invariant"; (4) "Conformal Geometry in the Complex Domain."

E. C. MOLINA, New York: "Expansion for Laplacian Integrals in Terms of Incomplete Gamma Functions."

O. ORE, New Haven: "Non-commutative Polynomials."

C. N. MOORE, Cincinnati: "Properties of Fourier Constants."

R. E. A. C. PALEY, Cambridge: See Wiener, *infra*.

G. Y. RAINICH, Ann Arbor: "Determination of Matter and Force Components, Riemann Tensor."

D. E. SMITH, New York: "On the Work of the International Commission on the Teaching of Mathematics." See also Gandz, *supra*.

J. J. SMITH, Schenectady: "Expression for Green's Function in Generalized Coordinates."

V. SNYDER, Ithaca: "Cremona Involutions Defined by a Pencil of Ruled Surfaces."

E. B. STOUFFER, Lawrence: "Projective Differential Geometry of Developable Surfaces."

J. L. SYNGE, Toronto: "Equilibrium of a Tooth with Conical Root."

J. D. TAMARKIN, Providence: See Hille, *supra*.

N. WIENER, Cambridge: "Analytic Properties of the Characters of Infinite Abelian Groups." (In collaboration with R. E. A. C. Paley.)

That America should have ranked so high in the number of papers read, as well as in the number of members present, would have been anticipated by only a few optimistic scholars at the opening of the present century. That these papers would have generally been of such a high grade would hardly have been thought possible.

As has been the case in other congresses, beginning with the one held at Rome in 1908, the section on education was devoted chiefly to the work of the International Commission on the Teaching of Mathematics. The leading events were the brief address by the retiring president and a report by Professor Loria (Genoa) on the mathematical preparation of teachers of secondary mathematics in the various countries represented at the congress. Owing to financial conditions, not all the national reports were completed, but it is expected that all the material will soon be ready for publication. One of the most elaborate reports appears to be that of the United States, prepared by a national committee, consisting of Professors Hedrick (*chairman*), Reeve, Luse, Young (deceased), Frazier and Sueltz, which will probably be completed before the close of the present year, extracts having been read by Professor Loria. The following officers were elected for the next four years: *President*, J. Hadamard, Paris; *Vice-presidents*, P. Heegard, Oslo, G. Scorza, Naples, and W. Lietzmann, Göttingen; *Secretary-treasurer*, H. Fehr, Geneva. These were constituted a central committee with powers to elect other members and national committees. On the motion of Professor Hadamard, the retiring president, D. E. Smith, of New York, was elected honorary president for life. The topic for investigation for the next four years is, "The Present Trend of Mathematics in the Various Countries of the World."

The congress was unable to provide for the publication of the papers read in the sections, but in the second part of its *Proceedings* brief summaries of

most of them will be printed. The general lectures will appear in the first part. Summaries of most of the section papers were distributed to members of the congress, but with numerous omissions, the manuscripts not reaching Zurich in time to be included.

The social features were well arranged. They included a reception on September 4, a concert on September 5, an excursion on the lake on September 6, a social gathering at the Municipal Theater on September 10, and a tea on September 11. The ladies of Zurich made a great effort to provide entertainment for the women guests in the way of teas, visits to the town and its museums, and a motorcar excursion to the Castle of Wildegg. There were also excursions at a moderate price to Klausenpass, the Rigi, Pilatus, the Lake of the Four Cantons and the Jungfraujoch. For the official delegates there was a special tea-party given at the beautiful château of Herr and Frau von Schulthess-Bodmer at Au.

There was a small exhibition of books and mathematical instruments in the Polytechnic School, generally of recent material, but in one case, by L'Art Ancien, of old books and manuscripts.

In spite of the general world depression, the attendance was satisfactory, although not as large as at some of the other congresses. It is expected that the next meeting will be held in 1936 at Oslo.

DAVID EUGENE SMITH

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

GENERAL LECTURES AT ATLANTIC CITY

FOR each meeting the association endeavors to arrange a series of general lectures to be delivered in non-technical language. These lectures are given in a semi-popular style, so that they can be easily understood by scientists who are not specialists in the field of work treated in the lecture and by the general educated public. Many of the points of the speakers are brought out by illustrations. Some speakers use lantern slides, some use motion pictures, and some even use research apparatus to demonstrate their points. On the other hand, many of the general addresses are of such a nature that they do not require illustration.

The association has been extremely fortunate in being able to secure an unusually representative series of lectures for the Atlantic City meetings. Eminent speakers have promised to discuss subjects in anthropology, mathematics, chemistry, physics, botany, zoology, meteorology, astronomy, sociology, dentistry and engineering. Some of the lectures will be held in the evenings, but most of them will be scheduled for 4:30 or 5:00 P. M. after the technical sessions of the societies.

Dr. Franz Boas, retiring president of the association, will give the first general evening lecture on Tuesday, December 27, at 8:45 P. M. in the Ballroom of the Municipal Auditorium, on "Anthropology and Its Aims." Following Dr. Boas' lecture, members of the association and friends will gather in the Rutland Room of Haddon Hall, the association's general headquarters hotel, for the general reception, which will begin at 10:15 P. M.

The second evening lecture will be given under the auspices of the Society of the Sigma Xi at a joint session of the association in the Ballroom of the Municipal Auditorium.

Dean Dexter S. Kimball, of the Engineering College of Cornell University, will deliver the third evening lecture on Thursday, December 29, in the Ballroom of the Municipal Auditorium. Dean Kimball has announced his title as "The Social Effects of Mass Production." This subject, which ought to be of interest to every one and especially to engineers and sociologists, is one to which Dean Kimball has for several years devoted serious thought.

A new general lecture has been established in memory of the late Hector Maiben, of Lincoln, Nebraska. The lecture will deal authoritatively with a topic of active scientific interest upon which the speaker possesses the right to an opinion in virtue of his own work. It will, however, be addressed to a general scientific audience rather than to specialists. The first Maiben Lecture will be given in the Ballroom of the Municipal Auditorium by Dr. Henry Norris Russell, of Princeton University, on "The Constitution of the Stars." Dr. Russell will review the recent work of Eddington, Jeans, Vogt, Milne and others, and will report on the present status of the problem.

The first of the afternoon general lectures will be given by Dr. O. H. Caldwell, editor of *Electronics* and formerly U. S. Radio Commissioner, on Tuesday, December 27, at 4:30 P. M. in Committee Room 12 of the Municipal Auditorium. Dr. Caldwell has chosen the subject "Electrons at Work."

On Wednesday afternoon at 4:30 P. M. in Committee Room 13, Municipal Auditorium, Dr. Carl Caskey Speidel, of the University of Virginia, will deliver a general address on "Nerve Growth and Repair." Dr. Speidel plans to illustrate his address with lantern slides and a motion-picture film, giving a record of nerve activities. It will be recalled that Dr. Speidel was awarded the association's prize of $1,000 at New

Orleans for his work on nerve growth and repair. An account of Dr. Speidel's prize paper is given in SCIENCE, for February 5, 1932.

A second general session will be held on Wednesday afternoon in the Smoking Room, Municipal Auditorium, for an address by Dr. Dayton C. Miller, of the Case School of Applied Science. In speaking on "The Physics of the Flute," Dr. Miller will describe the air currents producing musical sounds and will play a flute to illustrate his lecture.

The tenth Josiah Willard Gibbs Lecture will be delivered by Dr. Richard C. Tolman, of the California Institute of Technology, at a general session of the association and the American Mathematical Society on Thursday afternoon at 4:30 P. M. in the Vernon Room of Haddon Hall. Dr. Tolman, who is well known as a physicist, chemist and mathematician, has chosen the subject "Thermodynamics and Relativity."

A second lecture on Thursday afternoon at 4:45 P. M. in the Belvidere Room, Traymore Hotel, will be given by Dr. Mel T. Cook, director of the Insular Experiment Station at Rio Piedras, Puerto Rico, on the subject, "Personal Experiences in West Indian Hurricanes." Dr. Cook will give a botanical background to this lecture and will exhibit some lantern slides, showing the paths of cyclones in recent years. In addition, Dr. Cook will propose a theory to explain the origin and cause of hurricanes.

On Friday afternoon at 4:45 in the Benjamin West Room, Haddon Hall, Dr. Russell W. Bunting, professor of oral pathology at the University of Michigan and director of dental caries research under the Children's Fund of Michigan, will deliver a general address on "Recent Developments in the Study of Dental Caries." Every one interested in the present status of our knowledge of tooth decay will be interested in Dr. Bunting's lecture.

In addition to the above general addresses, many of the retiring vice-presidents and chairmen of the various sections of the association will deliver addresses of general interest. The titles of these as now known are as follows:

(1) "The Spontaneous Heating and Ignition of Hay and Other Agricultural Products," by Dr. C. A. Browne, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

(2) "The Rôle of Analysis in Scientific Investigation," by Dr. Douglas W. Johnson, Columbia University.

(3) "Genetics and Embryology," by Dr. Charles Zeleny, University of Illinois.

(4) "Crops and Civilization," by Dr. E. D. Merrill, New York Botanical Garden.

(5) "Photographic Records of Changes in Vegetation," by Dr. G. E. Nichols, Yale University.

(6) "The New Anthropology: Twenty-five Stages of Vertebrate Evolution from Silurian Chordate to Man," by Dr. W. K. Gregory, American Museum of Natural History.

(7) "The Historical Development of Response Psychology," by Dr. Herbert S. Langfeld, Princeton University.

(8) "Mediaeval Guilds of Medical Interest," by Dr. Howard T. Karsner, Western Reserve University.

(9) "Science and the Problem of Value," by Dr. Ernest Horn, University of Iowa.

(10) "Tendencies in the Logic of Mathematics," by Dr. Earle R. Hedrick, University of California at Los Angeles.

CHARLES F. ROOS,
Permanent Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A LEAST-SQUARES CURVE-FITTING MACHINE, USING SPRINGS

THE machine described herewith has been developed to meet a special need. Some features may be of enough general interest, however, to warrant an account of the problem and solution.

Breeders of dairy cattle are accumulating a large body of yearly records of production based on the milk yield and fat test of individual cows by calendar months. The problem is to measure the *rate* of milk secretion for each cow by fitting the data of the first eleven full months of lactation with the equation $y = Ae^{-kx}$, in which y is milk-energy yield per day, and x is time in months with origin at one month after calving.[1] The observed y's are computed by use of a special slide rule,[2] wherein the stops of the machine sketched in Fig. 1 replace the runner of the slide rule. When the eleven stops, representing the observed y's, are set the machine immediately indicates the fitted A and k constants, as explained in Fig. 1.

The present machine has been worked out by a sort of "cut and try" process,[3] without knowledge of any previous device along the same line. We have since learned that the spring principle of fitting a straight line to irregular observations was demonstrated some years ago by M. D. Hersey.[4]

[1] The use of this type of equation in the study of lactation was introduced by S. Brody and coworkers, *Jour. Gen. Physiol.*, 5, 441–443, 1923.

[2] *Jour. Agric. Res.*, 34, 373–383, 1927.

[3] The first model was constructed by the Hayes Machine Company, Urbana, Illinois. This was revised in the shops of the Department of Physics, University of Illinois, in which connection we wish to acknowledge the assistance of C. W. Fieg, shop mechanician.

[4] *Jour. Wash. Acad. Sci.*, 296, 1913.

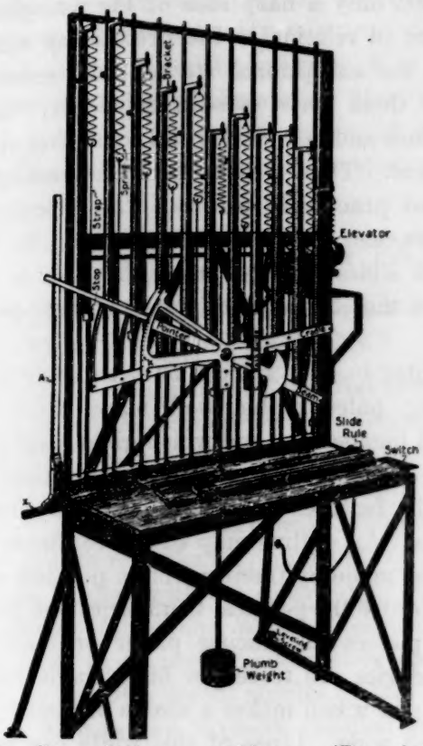


FIG. 1. Curve-fitting machine. (Description and operation of machine for fitting the equation $y = Ae^{-kx}$ to 11 observed y's).

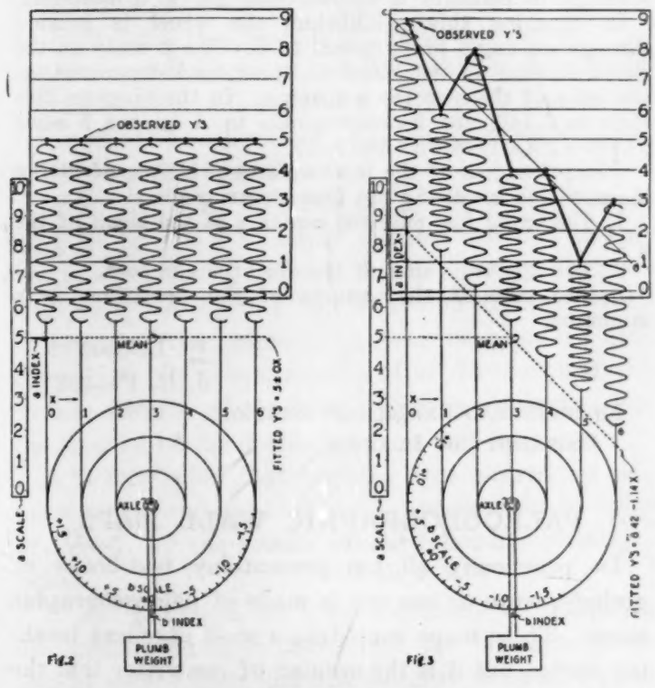
The machine has an erect framework carrying 11 brackets adapted to independent vertical movement. Each bracket carries one of a set of 11 uniform coil springs having no initial tension. The springs support a free-hanging cradle beam by thin metal straps rolling over arcs built into the beam. The beam has a central axle which carries by ball bearings a frame provided, at the left, with a k scale and, at the right, a rack guide. This frame, while free to move vertically with the beam, is held from rotational movement by a heavy plumb weight rigidly attached to it. The axle of the cradle beam also carries through a ball bearing a balanced pointer. A gear segment attached to the cradle beam meshes with a rack moving vertically in the rack guide. The rack is connected to the pointer by means of a pin operating in a center-line slot in the pointer. Rotational movement of the beam is thus communicated to the pointer in the ratio of angle and tangent.

In operation, the whole fitting assembly is raised to the top of the framework by the electric elevator, controlled by a switch. Each bracket is provided with a hanging stop. With the assembly elevated, the first stop is removed, placed on the 20-inch slide rule, the first observed y computed directly on the stop, and the stop replaced; similarly, for each of the other y's in succession. The assembly is now lowered, whereupon it comes to rest supported by the stops or observed y's, and the fitted constants are immediately indicated by the pointer on the k and A scales. The vertical A scale is a duplicate of the slide rule, and is movable laterally on the horizontal x scale to accord with the time origin.

The machine is adjusted as follows. Adjust leveling screws to cause the plumb weight rod to hang in the clear in the circular hole in the table top through which it passes. Unhook all the springs from their straps. Fasten the cradle beam in a horizontal position, that is, the pointer reads $k = 0$. Remove all the stops and set one of them at a suitable value. Proceeding one bracket at a time, hang this stop in place supporting the bracket, attach a weight to the spring sufficient to stretch it about one-half its working range, adjust screw from which spring hangs at top of bracket until lower hook of spring meets its point of attachment in strap. Having thus adjusted each spring, hook up all springs. Set all stops at the same value (say 5), hang in place supporting fitting assembly, and so adjust the A scale vertically in the slot at its base attachment that the pointer reads $A = 5$, (the k reading will be 0).

As a test on the accuracy of the machine fitting, 50 actual records were selected at random, but to include a wide range of k. These records had previously been fitted by least squares, algebraically. The range of k was from .170 to $-.018$. The results by the machine were then compared with the algebraic results by determining the Pearson product-moment coefficients of correlation. The A's showed, $r = .99992$; and the k's, $r = .99979$. The accuracy appears to be comparable with that of a 20-inch slide rule. It is of interest to note a similar comparison[2] of the k's as determined algebraically and graphically (that is, by plotting and eye fitting) which gave, $r = .956$.

The diagrams and explanation of Figs. 2 and 3 are given to further clarify the principle, and also as suggestive of a simpler design.



FIGS. 2 and 3. Diagrams to illustrate the use of springs in curve fitting. (Least-squares fit of the equation $y = a + bx$ to seven observations).

Seven uniform coil springs, without initial tension, suspended from the observed y's, support the uniformly stepped wheel and heavy plumb weight, by light bands which may be considered as weightless. In Fig. 2 the observed y's are all 5 and it is clear that $a = 5$ and $b = 0$, as indicated on the respective scales. Each spring supports 1/7 of the suspended weight and each undergoes the same stretch, l. The combined stretch of the springs is Σl or $7l$.

In Fig. 3 the observations are irregular, 9, 6, 8, 4, 4, 1, 3 from $x = 0$ to 6, respectively. The sum of the y's is 35 and the mean is 5, as before. The center of the wheel remains stationary since its position is dependent on Σy. The fitted line passes through the center x at

the mean of the y's, one characteristic of the least-squares principle.

The stretch of the springs in Fig. 3 varies. The line cd is drawn to make this more apparent. If all the observed y's were on cd the stretch of each spring would be the same, l. But, Σl remains constant and hence, the fitted line takes a position such that the sum of the plus deviations equals numerically the sum of the minus deviations, or the algebraic sum of the deviations is zero, a second characteristic of the least-squares principle.

The essential characteristic, the sum of the squares of the deviations is a minimum, may be explained in terms of energy, as developed by Hersey.[4] The coil spring with no initial tension and no stretch has no stored energy. As the spring is stretched the stored energy increases as the square of the stretch. In Fig. 2 the stretch of each spring is l and the stored energy of all the springs is Σl^2. In Fig. 3 the stretch of the springs is variable, $l+\Delta$, where Δ is the deviation of the respective observed y from the fitted y. The stored energy of the springs is $\Sigma(l+\Delta)^2$, or

$$\begin{aligned} &\text{for the } +\Delta\text{'s}, && \Sigma l^2 + 2\,\Sigma l\Delta + \Sigma\Delta^2 \\ &\text{for the } -\Delta\text{'s}, && \Sigma l^2 - 2\,\Sigma l\Delta + \Sigma\Delta^2 \\ &\text{for all } \Delta\text{'s}, && \Sigma l^2 \qquad\quad + \Sigma\Delta^2 \end{aligned}$$

The $l\Delta$ terms cancel since l is constant and the sums of the $+\Delta$'s and $-\Delta$'s are numerically equal. The system comes to rest with stored energy at a minimum and since Σl^2 is constant it follows that $\Sigma\Delta^2$ is a minimum.

In reaching this equilibrium the wheel is rotated through an angle proportional to b. The b scale on the circumference of the wheel is linear, and dependent on the ratio of the x to the y spacing. In the diagram this ratio is 1.146, and 5° corresponds to .1 on the b scale ($1.146 \times 2 \times 3.1416 \times 5 \div 360 = .1$).

Three features of the least-squares principle of fitting the equation $y = a + bx$ are thus shown mechanically:

1. The fitted line cuts the center x at the mean of the y's.
2. The algebraic sum of the deviations is zero.
3. The sum of the squares of the deviations is a minimum.

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PALEOGEOGRAPHIC WALL MAPS

IN practically all the present-day text-books of geology, more or less use is made of paleogeographic maps. These maps constitute a most excellent teaching device, but it is the opinion of the writer that the maps as published in most of the text-books are of but little value to elementary students. In all the text-books in use at the present time such maps are published in black and white and seas are shown by means of lined areas or some such device. All these devices so obscure the boundaries of land masses, political boundaries and so forth, which are also shown by black lines, that it is almost impossible to determine the relation of the seas to the present continents and political divisions. This difficulty is increased by the small scale necessarily used in the text-book publications. The result is that the average student gets only a hazy idea of the paleogeography of the past in relation to the present-day continents, and even the exceptional student who endeavors to study out these maps is soon hopelessly lost in the maze of lines and boundaries and soon gives up in discouragement. Thus a very excellent teaching device is rendered practically useless. The difficulty of the small scale can be partially overcome by the use of lantern slides of these maps, but this is of little help, since the confusion of lines and boundaries still exists.

The writer has for some time been using a method of making paleographic wall maps which is both rapid and inexpensive and which gives maps on which students can see at a glance the position of past geographic features in relation to the present-day continents. An outline map of the continent in question is first made by tracing from a political wall map of suitable size the political boundaries and boundaries of land masses on tracing paper or tracing cloth. All boundaries are traced in black India ink with a lettering pen which makes a stroke of about an eighth of an inch wide. Lines of this width can usually be distinguished anywhere in the ordinary lecture room. Care should be taken not to use too much detail, but enough should be included so that no student will have any difficulty in locating any place on the map with regard to its present-day political boundaries or the boundaries of the land masses. From this outline map a large number of outline maps are prepared by tracing them on tracing paper of the kind used by architects in making preliminary plans of buildings. These outline maps are then used as needed in preparing paleographic maps of any period or epoch. Using the same kind of a lettering pen the boundaries of the seas are drawn in with some sharply contrasting color such as bright red. In this way the boundaries of the seas are never confused with the political and other boundaries drawn in black on the outline map. The areas of the seas are then roughly colored with soft blue chalk (not crayon) and then carefully rubbed with a small piece of cotton cloth. This rubs the color into the paper sufficiently that it is not rubbed off by handling and distributes the color evenly over the map. The seas now stand out in strong contrast to the land areas, and the political and other boundary lines are not in the least obscured by the coloring. As a result students grasp the situation immediately as soon as one of the maps is shown to them and get a clear conception of all the geographic features of the past with their relation to the present-day configuration of the continents. The tracing paper map when finished is mounted on muslin in the usual way and makes a very durable map. After the preliminary outline maps are made a

paleographic map can be made from any of the published maps in fifteen to twenty minutes. Since this method is both rapid and inexpensive, it is possible to have a large number of these maps illustrating not only periods but all important epochs of a period. The writer has found that not only do students grasp many of the facts of historical geology better by this method but that its use greatly adds to the pleasure of both the student and instructor.

LEROY T. PATTON

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SPECIAL ARTICLES

THE STRUCTURE OF VITAMIN A AND THE SYNTHESIS OF IONENES

THE brilliant investigations of the past two or three years, here as well as abroad, on the chemical nature of vitamin A, which culminated in the structural formula (I) proposed a year ago by Karrer, Morf and Schöpp,[1] have directed increasing attention to this compound and its remarkable properties.

An article, dealing with the constitution of vitamin A, by Heilbron, Morton and Webster,[2] which has just appeared, leads us to report immediately and briefly the results of our own recent studies of this problem.

Heilbron, Morton and Webster distilled vitamin A concentrate with finely powdered selenium and obtained 1,6-dimethylnaphthalene (VI) as one of the principal products. As a possible explanation of this reaction, they suggest the preliminary cyclization of the vitamin to a hydronaphthalene derivative (II), which then breaks down to ionene (III), for Ruzicka and Rudolph[3] have shown that when ionene is distilled with sulfur 1,6-dimethylnaphthalene results and, as is well known, the action of sulfur in such distillations is similar to that of selenium.

It is obvious that, whatever the mechanism may be by which ionene is formed from the vitamin, the value of this observation of Heilbron, Morton and Webster's, in throwing light upon the constitution of the vitamin, depends upon the establishment of the constitution of ionene itself, and that is one of the phases of this vitamin problem which our organic laboratories at Columbia University have been studying for some time and which we believe that we have now brought to a successful conclusion, through the investigations of Dr. David Davidson and Messrs. Victor G. Fourman and Percy M. Apfelbaum.

Ionene was discovered by Tiemann and Krüger[4] by the dehydration of *alpha*-ionone, or of a mixture of *alpha*- and *beta*-ionones. Later, Tiemann[5] showed that it could be prepared also from *beta*-ionone.

On the basis of the products obtained from it by oxidation, Tiemann and Krüger were disposed first to assign to ionene constitution (IV), but finally decided in favor of formula (V).

Three years later, Barbier and Bouveault,[6] proposed the structure (III) as the more probable one for ionene, but cited no new experimental work in support of this opinion. Tiemann,[7] in reply to Barbier and Bouveault, insisted upon the correctness of his own formula (V) and quoted his original oxidation experiments.

Baeyer and Villiger[8] investigated the constitution of ionene, by their exhaustive bromination method, confirmed the existence of the carbon skeleton common to all three of the suggested ionene formulas, but threw no light upon the location of the double bonds.

Auwers and Eisenlohr,[9] as the result of their study of the molecular refractivity of ionene, decided in favor of (IV) rather than (V), but apparently failed to consider (III) at all.

In the course of their researches in the naphthalene field, Ruzicka and Rudolph[3] distilled ionene with sulfur, as noted above, and obtained 1,6-dimethylnaphthalene, using the Barbier and Bouveault formula (III) to illustrate the reaction. A year later, in his brochure[10] on the sesquiterpenes, Ruzicka accepted the carbon skeleton of the ionene formula as proven, but the location of the double bonds as still unknown.

It is our belief that we have now cleared up this uncertainty, and established the complete constitution of ionene, by the results of the following investigations:

I. Mr. Fourman, by a careful study of the nitro, nitroamino and sulfo derivatives, the oxidation products of ionene itself and of its dinitro derivatives, has made it quite evident that the Barbier and Bouveault formula (III) for ionene is correct.

II. Davidson and Apfelbaum have now demonstrated the accuracy of this deduction by the synthesis of ionene through these steps:

[1] Karrer, Morf and Schöpp, *Helv. Chim. Acta.*, 14, 1434 (Dec., 1931).

[2] Heilbron, Morton and Webster, *Biochem. J.*, 26, 1194.

[3] Ruzicka and Rudolph, *Helv. Chim. Acta.*, 10, 918 (1927).

[4] Tiemann and Krüger, *Ber.*, 26, 2693 (1893).

[5] Tiemann, *Ber.*, 31, 873 (1898).

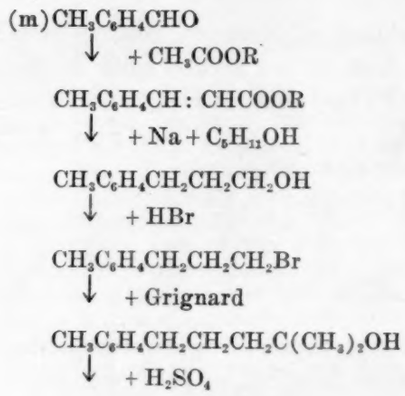
[6] Barbier and Bouveault, *Bull. soc. chim.* [3], 15, 1008 (1896).

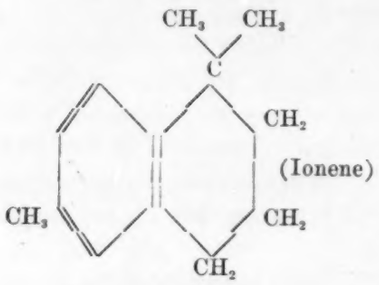
[7] Tiemann, *Ber.*, 31, 854 (1898).

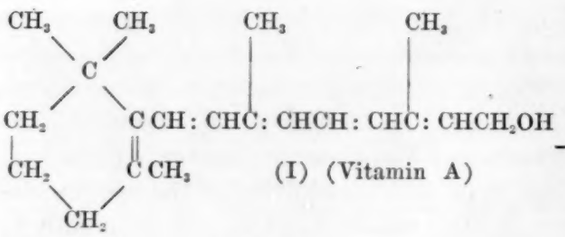
[8] Baeyer and Villiger, *Ber.*, 32, 2429 (1899).

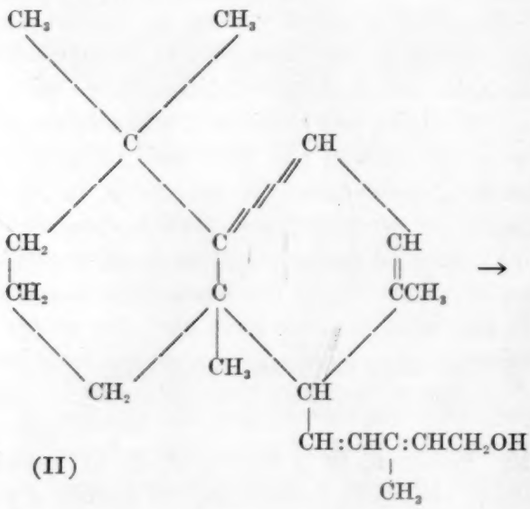
[9] Auwers and Eisenlohr, *J. prakt. Chem.* [2], 84, 61 (1911).

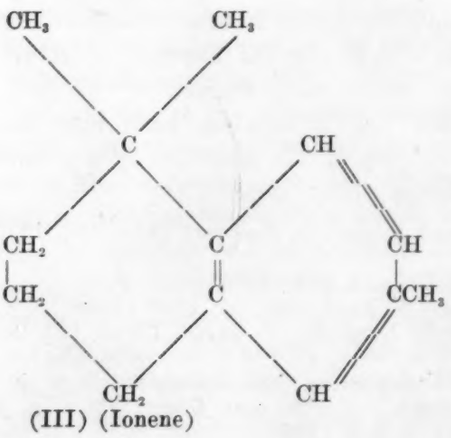
[10] "Über Konstitution und Zusammenhänge in der Sesquiterpenreihe," *Fortschr. d. Chem., Phys. u. phys. Chem.*, 19, No. 5, p. 9 (1928).

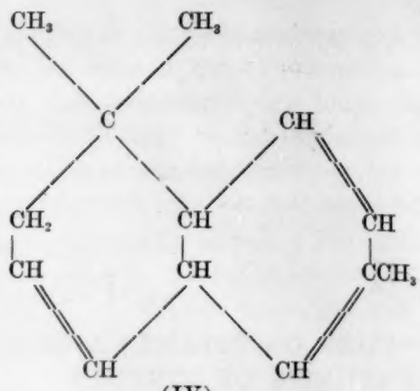


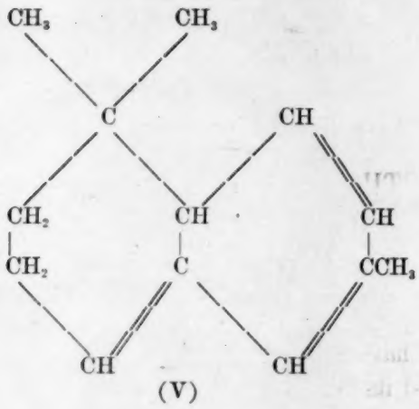


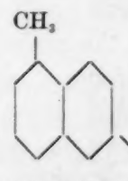












The ionene so synthesized is identical in all respects with that prepared by the dehydration of either *alpha*- or *beta*-ionone, and we have already utilized similar reactions for the synthesis of other ionenes and analogously constituted compounds.

Detailed articles describing these syntheses in full, as well as the work of Mr. Fourman, will be published elsewhere and will appear shortly.

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